Popular Science

SM

MONTHLY Founded 1872

March
1929
25 cents

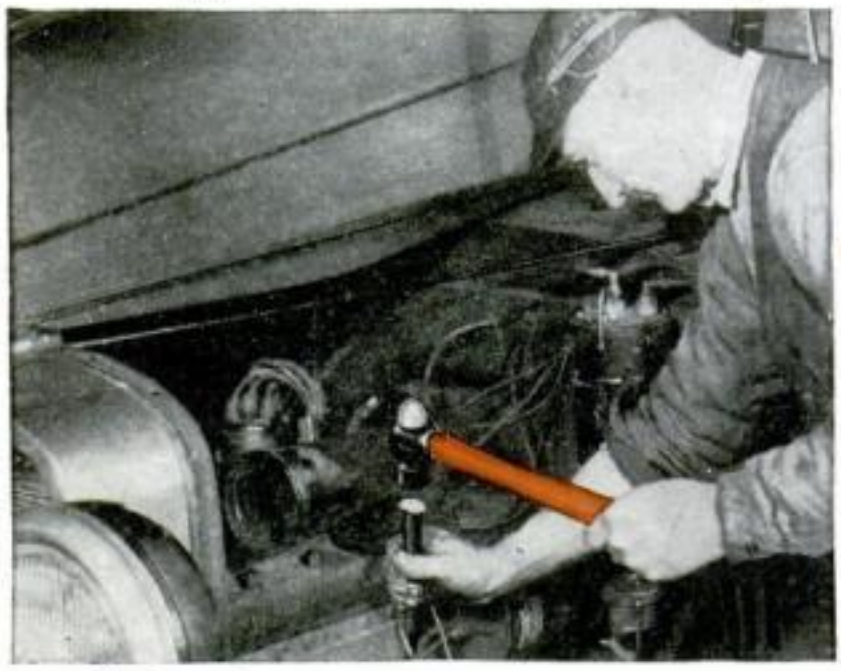
Beginning in This Issue:—

I AM LEARNING TO BE A FLYER

Vivid Experiences of a Greenhorn Student Pilot

Chosen by experts and champions everywhere

For the guidance of hundreds of thousands of Boy Scouts, the Official Headquarters selected the Plumb Scout Axe as an Official Scout Axe of the organization.



The Garage Man says—

"The off-center head of the Plumb Ball Pein gives me the power I need on heavy work. Yet the tool is so finely balanced I can use it where a false blow would do lots of damage."
—GEORGE BREYER, Phila.

The Carpenter says—

"My Plumb Nail Hammer fits my hand like a glove. That broad face never misses a nail. Those "nipper" claws pull anything. It's just the kind of a hammer I would reach for if there were a dozen others around."
—DANIEL S. SCHOENER, Glenside, Pa.

The World Champion Chopper says—

"I give the Plumb Axe the credit for victory in many of my chopping contests. That axe saves me one minute in a five-minute chop. Plumb has developed the correct steel for axes; has perfected the design of blade for fast, easy cutting. I use only Plumb Axes in all my contests."
—PETER McLAREN

You, too, can do better work with these finer PLUMB *Tools*

Wage craftsmen deal with logical facts. Their time and ability are turned into money *with tools.*

The price of a tool means nothing. It's the grip . . . the feel . . . the performance of the tool that counts. Cheap tools are *too expensive* for their use. They know a poor tool does *cheap* work and mighty little of that.

Carpenters, mechanics, machinists: They form an impressive jury of experts, —and their verdict is . . . "Quality Tools." Many add "I use Plumb."

Or take that famous World Champion Chopper, Peter McLaren: Daily his reputation is staked on the blade of his axe. *He* uses only Plumb.

The Foreman Builder says—

"I've never seen a steel blade that bites into the wood, or that holds its edge like my Plumb Hatchet. And it works with my arm better than any tool I ever owned."
—AL. MOLLENKOF, Willow Grove, Pa.

Or the Headquarters of that tremendous organization, The Boy Scouts of America: When selecting a Scout Axe to adopt as *Official*—they picked *Plumb.*

Experts and champions everywhere use Plumb Tools! For better work . . . for a life-time of service. You, too, can do better work, with these finer tools.

Drive a nail with a Plumb. Watch how that broad face falls naturally on the head of the nail. Every blow counts!

Or pull the slimmest brad, even though it has no head.

Or the hatchet. Sink the blade deep, or slice just a shaving. That keen edge goes where you aim it.

The Ball Pein for heavy duty; the Plumb Axe for your chopping; the Plumb Official Scout Axe as a handy tool for garage or cellar.

Every one a fine tool. Fine in design, in balance, in finish,—in every detail.

And every Plumb has a safety feature that no other tool contains! When a Plumb Handle loosens (as all handles do) you just turn the patent screw to tighten it again.

Ask your hardware man to show you Plumb Tools. The Red Handle and Black Head will identify them for you.

PLUMB
DOUBLE LIFE
Hammers Hatchets
Files Sledges Axes

FAYETTE R. PLUMB, Inc., Philadelphia, U. S. A.

WHAT IS NEW THIS MONTH

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March, 1929, Vol. 114, No. 3. **Popular Science Monthly** is published monthly at 250 Fourth Avenue, New York, N. Y., by the Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Chicago, Illinois. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A. Copyright, 1929, by the Popular Science Publishing Co., Inc. Single copy, 25 cents. Yearly subscriptions to United States, its possessions, and Canada, $2.50; foreign countries, $3. The contents of this magazine must not be reprinted without permission. In presenting in its editorial columns numerous stories of new products of applied science, **Popular Science Monthly** does not underwrite the business methods of the individuals or concerns producing them. The use of **Popular Science Monthly** articles for stock-selling schemes is never authorized. O. B. Capen, President and Treasurer; R. C. Wilson, Vice-President; A. L. Cole, Secretary.

Engineering

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Ideas for the Handy Man

How Jack Nevins Made Sure of His Family's Financial Future

By WALLACE AMES, *Financial Editor*

CHAPTER I

"COME, Bubbles, show Daddy your new Toofie," coaxed Mrs. Nevins as she chucked their baby's chin. "See it, Daddy! It just came through today."

"That's going some," exclaimed Jack Nevins. "Only six months old, and already cutting teeth!"

"That isn't all," added Mrs. Nevins. "The little tike has learned to crawl, too. Come on, Bubbles, let's show Daddy." After proper coaxing, shaking of rattles and a series of flourishes to attract his attention, sure enough Bubbles started squirming his way over the floor.

"'Pon my word, he's some kid—a regular acrobat," said Mr. Nevins, with no attempt to conceal his pride. "Gee! I've sure got a fine little family," as he embraced both mother and baby. "I wish I could do more for them."

"Do more for us, Jack?" half-reproached Mrs. Nevins. "Why, we're just as comfortable as can be, and we're getting ahead, too. Guess I haven't shown you our Building and Loan account book lately. Here it is. Look at that total. We've got $600 stowed away for the future, and we only started saving a year ago."

"That's fine, Myra; you're a great little manager, and I give you all the credit for the fact that we're getting along so nicely, but how far would $600 go—or $6,000—if something should happen to me so that you and Bubbles would be without your bread-winner?"

"Don't talk that way, Jack. Nothing is going to happen," assured Myra.

"Probably not, but we never know when we're next. Furthermore, how about the advantages we want Bubbles to have as he grows up? We want him to go to college—and make the football team. How can we be sure that the money will be available when he graduates from high school?"

"Oh, there are a lot of things I wish were better provided for."

"Maybe they will be some day," suggested Mrs. Nevins. "In the meantime, I think we are mighty fortunate, and I for one am perfectly happy."

CHAPTER II

Jack Nevins—a young business man, junior executive in a large company, earning $4,000 a year, with good prospects of increasing his income year by year for many years to come is the type that reaches a fair degree of financial independence between ages 50 and 60. But Nevins rightly wanted to *insure* his family's future financial comfort *at once*. And that is just what he did, not long following the episode just related—with a modern, easily paid for program of life insurance.

Note the emphasis on the word "modern." Life insurance is one of our oldest financial institutions. But the public viewpoint and the use of life insurance has undergone as great a change in recent years as everything else. No longer is the life insurance agent the subject of stock jokes; no longer is he regarded as the common pest, the man to dodge. The trained representatives of up-to-date insurance companies are of the utmost help to every man in regulating and fortifying his financial future and the safety of his family.

The following program, worked out by Jack Nevins and his insurance adviser is typical of the modern way of providing for life insurance protection.

1. The first feature of the Nevins program is a "Clean Up" Fund of $2,000. This is covered by an Ordinary Life Policy of $2,000, payable immediately to Mrs. Nevins in the event of her husband's death. The object of the "Clean Up" Fund is to defray sickness and funeral expenses, and to settle outstanding bills that accumulate at such a time—bills, which, unless especially provided for, might prove particularly embarrassing and troublesome to the widow.

2. The second feature of the Nevins program is a $1,000 Endowment Policy reserved to help finance the higher education of the infant son. Thus the parents have made sure *Continued on page 5)*

A Service for Readers

THIS Financial Department is to help readers in the establishment of proper financial programs at the beginning of their business careers; it assists those who have accumulated money in the proper investment of it.

The Editor of this Department is an authority on investment matters. He is ready to aid in personal investment problems. Advice will be gladly given regarding the proper investment of funds and proper plans of saving.

Address your inquiries to Wallace Ames, Financial Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York. While investments obviously cannot be guaranteed by the Publisher, every effort will be made to insure that only advertisements of absolutely reliable companies are accepted.

How Jack Nevins Made Sure of His Family's Financial Future

(Continued from page 4)

that, regardless of their future financial situation, when the boy is ready for college the money will be available to give him the start.

3. The third feature (really the first in importance) is a *guaranteed* Monthly Income for Mrs. Nevins for as long as she survives Mr. Nevins. In her case the amount of guaranteed income was $95 a month, although (based on present records) the amount actually paid should be about $110 per month.

Mrs. Nevins is not to receive a lump sum in settlement of all the insurance—possibly to be risked in uncertain investments. The widow, unskilled perhaps in investing money, will not have to assume sudden and unwelcome financial responsibilities; nor will she be placed in the position of prospect for the "get-rich-quick" gentry. Her income is to be paid regularly and surely by the insurance company—with even greater certainty than Mr. Nevins' pay-day.

III

What will the Nevins' insurance program cost? The answer is: Practically nothing!

The first year deposit is about $523; second year, about $412; and as the dividends increase year by year, reducing the amount of the net premium, or deposit, the average deposit over a 20-year period is $365—slightly less than 10% of Mr. Nevins' present annual income.

Beginning at age 30 and continuing to age 65, the total deposits will be about $11,465. At age 65 the cash surrender value of the insurance will amount to $11,250—which means that protection for 35 years costs only $215, or $6 a year.

At age 65 Nevins can cease making further deposits, convert his insurance into a "Joint and Survivor Annuity," and collect a monthly income of $73 as long as either he or hiswife lives.

IV

The modern viewpoint on life insurance is, not how much it costs, not what a nuisance the deposits are to make, but how cheap it is, how much the insured gets for his money, how nearly perfect a plan it is to make sure of the financial future, during the earning and accumulating years of one's business career.

This article is accompanied with a table which shows how the Nevins program could be adapted to incomes of various sizes between $5,000 and $10,000 a year. Each program calls for average annual deposits of slightly less than 10% of the yearly income. If these deposits are paid in monthly instalments, as can easily be arranged, their payment is not a hardship and their benefits are immeasurable.

* * * *

By the addition of approximately 2½% to the amount of (Continued on page 6)

How Jack Nevins Made Sure of His Family's Financial Future

(Continued from page 5)

the first year deposit (see table) and by continuing to pay that small additional amount yearly, the insured can obtain what is known as "waiver of premium" clause. Then in case of total disability the insurance is kept in force without further deposits; or in case of temporary disability extending over a longer period than three months, no deposits need be made during the period of disability.

This feature adds very little to the cost of insurance, and makes certain that it will not lapse during a most critical period.

A MODERN INSURANCE PROGRAM

For Families of Various Incomes

Insured - - Age 30
Wife - - - - " 27

Approximately 10% of Income Available

Annual Income	$5000	$6000	$7000
Clean Up Fund	$2500	$3000	$3500
Education Fund	1500	2000	2000
Guaranteed Monthly Income for Life	116	133	160
*Average Income for first 20 years	134	153	185
First Year Deposit	646	750	891
*Second Year Deposit	509	590	701
*20-Year Average Deposit	444	515	612
Cost of "Waiver of Premium" Clause	16	19	22
*Total Deposits to age 65	13808	16426	19520
Cash Value at age 65	13914	16180	19182
Joint & Survivor Annuity at 65—Monthly	101	118	140

Annual Income	$8000	$9000	$10,000
Clean Up Fund	$4000	$4500	$5000
Educational Fund	2000	2000	2000
Guaranteed Monthly Income for Life	185	210	230
Average Income for first 20 years	214	243	266
*First Year Deposit	1022	1153	1260
*Second Year Deposit	805	908	1093
*20-Year Average Deposit	704	792	866
Cost of "Waiver of Premium" Clause	25	28	31
*Total Deposits to age 65.	22400	25293	27634
Cash Value at age 65	21982	24782	27077
Joint & Survivor Annuity at 65—Monthly	161	181	198

*Based on present Dividend Rate; not guaranteed.

(Continued on page 7)

How Jack Nevins Made Sure of His Family's Financial Future

(Continued from page 6)

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

"How to Build an Independent Income" is the title of a new booklet by the F. H. Smith Company which explains conclusively how people of moderate means may obtain financial prosperity. **"55 Years of Investment Service"** describes the history of progress of the F. H. Smith Company as well as making an attractive suggestion in first mortgage real estate bonds. May be obtained by addressing the home office of The F. H. Smith Company, Smith Building, Washington, D. C.

The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

"The Investment Trust from the Investor's Viewpoint," presents an explanation of this form of investment in easily understood terms, illustrated with some interesting examples of how the general investment trust will help the man with $100 or more to get ahead. Published for free distribution by United States Fiscal Corporation, 50 Broadway, New York. Ask them for Booklet IT.

How to Retire in Fifteen Years is the story of a safe, sure and definite method of establishing an estate and building an independent income which will support you the rest of your life on the basis of your present living budget. Write for the booklet to Cochran & McCluer Company, 46 North Dearborn Street, Chicago, Illinois.

How to Get the Things You Want tells how you can *use* insurance as an active part of your program for getting ahead financially. Phoenix Mutual Life Insurance Company, 328 Elm Street, Hartford, Conn., will send you this booklet on request.

The Guaranteed Way to Financial Independence tells how a definite monthly savings plan will actually bring you financial independence. Write for this booklet to Investors Syndicate, 100 North Seventh Street, Minneapolis, Minn.

The Making of a Good Investment tells how 6½% can be made on investment in First Mortgage Bonds in units of $50, $100, $250, $500 and $1000; how the bonds are protected and how simple it really is to purchase them. For a copy of this booklet address United States Mortgage Bond Company, Limited, Detroit, Michigan.

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Guaranteed Advertisements

Popular Science GUARANTEE

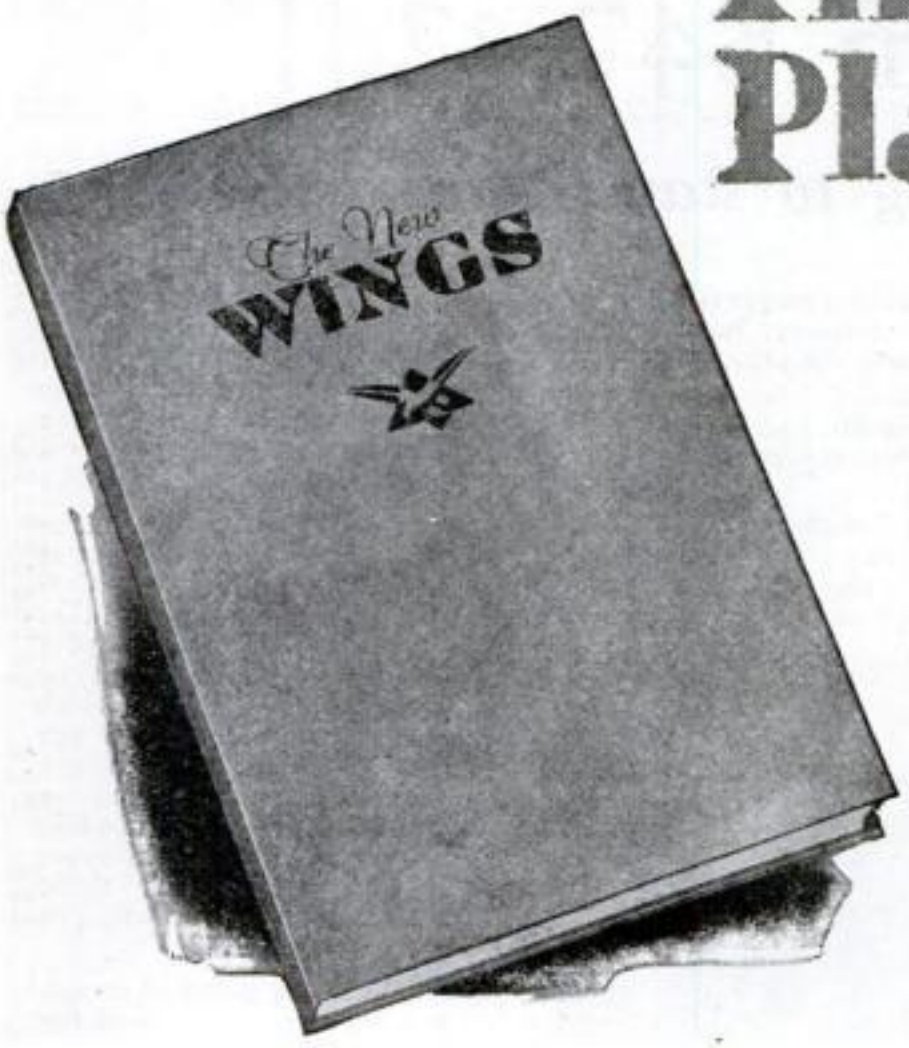
POPULAR SCIENCE MONTHLY guarantees every article of merchandise advertised in its columns. Readers who buy products advertised in POPULAR SCIENCE MONTHLY may expect them to give absolute satisfaction under normal and proper use.

Tools, Radio Apparatus, Oil Burners and Refrigerators advertised in POPULAR SCIENCE MONTHLY have been tested or investigated by the Popular Science Institute of Standards and each advertisement carries the insignia indicating approval.

However, other products advertised in the magazine not subject to test carry the same guarantee to readers as products tested.

THE PUBLISHERS

The new booklet WINGS describes the Guild plan fully. The coupon will bring you a copy, free, by return mail.



The NEW GUILD Plan Offers You

1. **Free Membership!**
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and NOW— A GUARANTEE of COMPLETE SATISFACTION

THE Literary Guild is the only organization of its kind in America. It offers you *free membership* in an association engaged in sponsoring the best books published. You pay only a small annual subscription for twelve outstanding books a year—one each month—much less than the same books would cost you if bought in any other way. *And* NOW in addition to all of the features that have brought the Guild its 70,000 members—*Now your complete satisfaction is guaranteed!*

Heretofore *The Literary Guild* has offered cultured Americans a rare opportunity to economize on a selected list of twelve of the best books published each year. The advantages of the offer, the quality of the books chosen, the merit of the entire plan have been so remarkable, so *unique*, that more than 70,000 men and women have subscribed. Now to this all but perfect plan has been added a new feature which makes it impossible for you to lose. To the biggest book bargain ever offered has been added *the privilege of exchanging a selection which does not meet with your approval.*

The NEW Guild Plan

The Literary Guild is in constant, intimate contact with the book supply of America. Months before publication the Guild knows what major manuscripts leading publishers plan to issue. Authors and literary agents also submit their books. From the best of all this available material one book is chosen each month. It is printed expressly for the Guild, bound in a distinctive Guild binding of the very best cloth and delivered to members by mail *postpaid*, on the day of publication.

When the booksellers are receiving their regular trade edition, you are receiving the exclusive Guild edition. The retail prices of these books vary through the year, but no matter how much the separate titles cost elsewhere *the subscription price to you remains the same for the entire twelve books.*

Most Guild books are fiction but a great many are not. Essays, poetry, travel and biography are included in a reading fare so varied that in the first two years of its existence an amazingly high percentage of its members have renewed their subscription, many of them saying *they wish to belong for life.*

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Among the past Guild selections have been such popular and expensive books as TRADER HORN, BLACK MAJESTY, AN INDIAN JOURNEY, FRANCOIS VILLON, HAPPY MOUNTAIN and MEET GENERAL GRANT.

The phenomenal growth of the Guild to its present size has been responsible for this added feature which makes its plan the most satisfactory and economical method of book buying ever devised. While the membership was limited to a few thousand members the Editorial Board had little difficulty selecting books which would please every member. Now, with the membership rapidly approaching 100,000 there are almost certain to be some members who will prefer another book to the Guild selection—some time during the year. For that reason it has been made possible for members to exchange a Guild book for any book now in print in America.

Mail the coupon at once for the NEW WINGS which fully describes the Guild plan, or, if you prefer, your bookseller will give you complete details.

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NEW YORK CITY

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Please send me a copy of your new booklet, WINGS which fully describes the Guild plan. No obligation to me, of course.

Name.....

Address.....

City.....State.....

Neglect of Home-Study Training Cost This Man $47,424!

How much are you paying to stay untrained?

Some time ago we received a letter which every man working for a living ought to read—whether he's making $20 a week or $200. Here it is:

"During the forty years that I have been working, my salary has averaged less than twenty-four dollars per week with the exception of the last two years while I have been acting as foreman. I made good in this position and saw, through the failings of others, what would happen to me unless I found a way to train for larger responsibilities.

"I had read of correspondence courses and began searching for one I thought would benefit me. I found it in the LaSalle Modern Foremanship course, and benefited by it, my salary being nearly doubled, and I was promoted from foreman to factory superintendent.

"This happened in a period of about ten months, and by devoting only about four or five hours per week to the studies.

"I am now enrolled as a member of the Industrial Management course, and find the work very interesting and beneficial. It can be applied every day in the factory, and brings results.

"I regret that I put it off to so late a day in life to reap the benefits I am now enjoying, and can truthfully say to younger men that if they would only profit by the experience of others they can gain more knowledge through one year's training by LaSalle methods than can be obtained in ten years' practical experience by hard work."

We quote the above letter not because the man who wrote it is making a staggering salary as a result of his training, but because it illustrates so clearly the principle behind LaSalle training.

Here is a man who all his life had accepted the thought that he was compelled to work for little or nothing.

For one thousand, nine hundred and seventy-six weeks the writer of this letter *paid at least $24 a week for the doubtful privilege of staying in the ranks of untrained men.*

Can anyone doubt that training would have doubled his salary just as easily when he was thirty-eight years younger—when he could attack his work with the abundant energy of a younger man?

Yet his neglect of this main avenue of progress cost him—leaving simple and compound interest out of the reckoning—the appalling sum of $47,424—a fortune in itself.

If You Could Use $47,424, Pause Before You Turn This Page

Perhaps you are already making quite as much as the writer of that letter—perhaps more. Perhaps, on that account, you may think that his experience does not apply to YOU.

But if training in Higher Accountancy—or Modern Salesmanship—or Business Management—or Law—or Business Correspondence—or any of a dozen other branches of business could change your forty-eight dollars into no more than $72 a week (which is easily possible) and if you now NEGLECT to advance yourself through the training you need—will you not find it difficult, thirty-eight years from now, to explain to those who are dear to you why you threw away $47,424?

We're not going to moralize. We're not even going to cite any of the thousands of letters from men who have not merely increased but doubled and tripled their incomes through home-study training under the LaSalle Problem Method. We *have* the letters. We will *show* them to you, if you like. But understand, please, that they would not *alter* the facts—they would merely *emphasize* them.

Below this text there is a coupon. It will bring you not only full details of the training that appeals to you, but also a copy of that most inspiring book, "Ten Years Promotion in One."

If you are sincere in your desire for advancement, you will not turn this page until you have clipped the coupon, filled it in, and by placing it in the nearest mail box placed *yourself* on the road to real success.

LaSalle Extension University

THE WORLD'S LARGEST BUSINESS TRAINING INSTITUTION

Find Yourself Through LaSalle!

If You Are Thinking About Stenography or Secretarial Work—

If you want to start right and advance rapidly, investigate Stenotypy, "the machine way in shorthand"—the preferred way to the better position.

Stenotypy adds to your personal ability the accuracy, speed and ease of the machine. Easy to learn, easy to write and easy to read. You start with an advantage—and that advantage increases. The Stenotype means faster, better work, and better work means better pay. The demand for Stenotypists exceeds the supply.

Send the coupon for a free trial lesson. See for yourself how the Stenotype opens unusual opportunities for you.

LASALLE EXTENSION UNIVERSITY, Dept. 383-R CHICAGO

I would welcome an outline of the LaSalle plan, together with a copy of "Ten Years' Promotion in One," all without obligation.

- ☐ Business Management: Managerial, Sales and Executive positions.
- ☐ Higher Accountancy.
- ☐ Expert Bookkeeping.
- ☐ C. P. A. Coaching.
- ☐ Modern Salesmanship.
- ☐ Traffic Management.
- ☐ Railway Station Management.
- ☐ Modern Business Correspondence.
- ☐ Stenography—Stenotypy.
- ☐ Law: LL.B. Degree.
- ☐ Industrial Management.
- ☐ Modern Foremanship.
- ☐ Personnel Management.
- ☐ Banking and Finance.
- ☐ Credit and Collection Correspondence.
- ☐ Business English. ☐ Effective Speaking.
- ☐ Commercial Law. ☐ Commercial Spanish.
- ☐ Telegraphy—Railway and Commercial.

free! mail coupon now

Name ..... Present Position ..... Address .....

Choosing Tools to Last

Tests by the Institute, Instead of Expensive Experience, Now Guide the Purchaser

By MAJOR CARLOS DE ZAFRA

Assistant Director, Popular Science Institute

This ingenious testing device is used by the Institute in determining the merits of various screw drivers. It proves six points in construction which are essential in estimating a screw driver's merits.

THE man who uses tools accumulates in time a fair knowledge of what tools are good and will stand up under usage. But, ordinarily, it takes long experience and considerable expense to acquire this knowledge. Meanwhile, many poor tools have been bought and discarded; many jobs unsatisfactorily done.

If wisely selected, most tools will last a lifetime and, with this in mind, a tool testing service was started five years ago by Popular Science Institute to provide readers of POPULAR SCIENCE MONTHLY with information enabling them to buy the right tools *the first time*. In connection with this service, this magazine has maintained a protective policy of omitting the advertising of any inferior tools.

Any organization must have a sound basis for determining the worth of tools or other products; labeling a tool "good" means nothing at all unless there is extraordinary experience and impartiality behind the judgment. Such experience and impartiality govern approvals by Popular Science Institute. All tests by The Institute are made in Sage Research Laboratory of New York University and are carried to a point that provides accurate and complete information. All decisions regarding approval are entirely in the hands of Prof. Collins P. Bliss, Director of Popular Science Institute and Associate Dean of the College of Engineering of New York University. He is also Consulting Engineer of the Bureau of Standards at Washington, representing the Bureau on the Small Tools Committee of the Federal Specifications Board.

One of the chief problems that has faced the Popular Science Institute of Standards in the testing of tools—and other products as well—has been to provide suitable testing equipment that would definitely bring out the facts regarding the product under test.

FOR instance, to determine the lasting powers of a tool it is necessary to devise both tests and testing apparatus that will enable The Institute to duplicate exact working conditions in such a way that the tool being tested artificially receives years of wear in a few hours.

It is rarely possible to go out and buy testing equipment for the reason that comparatively few commercial testing devices of this character are available. That is why the engineers of Popular Science Institute have had to exert considerable effort and ingenuity in devising methods and equipment before proceeding with the actual testing of tools. The Institute's activities in the tool-testing line have been under way for five years and, while we have reason to feel satisfied with the testing apparatus in use, and consider the test findings sufficiently accurate and complete to provide a basis for determining the worth of tools, we fully recognize that there is still room for improvement—and probably always will be.

With this fact in mind, our engineers are constantly at work improving test methods and originating new testing apparatus. Steady progress has been made, due to the experience gained and also to the very fine coöperation The Institute has received from outside sources.

One of the latest developments in the line of tool-testing equipment is the rather ingenious machine for testing screw drivers that is illustrated in the accompanying photograph. The particular advantage of this device is that in practically one operation it determines the following six points which are all very essential in estimating the merits of a screw driver undergoing a test:

(1) The brittleness or toughness of the tip.

(2) The tightness of the connection between the shank and the handle.

(3) The limit of bending the steel will stand without being permanently deformed.

(4) How much pressure the tip will stand without breaking.

(5) The relation between strength of the tip and strength of the shank.

(6) It also is possible to determine in definite figures the twisting effort required to drive a screw driver.

THE twisting force is applied by means of the beam shown with the two weights hanging from it. The weight at the back of the machine is simply to counterbalance the weight of the beam and its clamps, so that when the screw driver tip is placed in the slot the only load or stress applied to it is by the measuring weights.

In the chuck of the machine a hardened screw slot is rigidly fixed so it cannot slip under any load. Weights are applied in a clockwise direction and the twist or deformation is recorded on the protractor mounted on the head of the machine. The behavior of parts of the screw driver during the application of the loads is carefully watched.

Just at present, this screw driver arrangement is being used in making some particularly interesting tests. Under the direction of Dean Bliss, the work of the Popular Science Institute has been recognized by the U. S. Bureau of Standards and a special series of tests on screw drivers is being carried on to assist this Government organization. Information acquired from these tests will be used by the Federal Specifications Board in setting up specifications for screw drivers.

The device for testing screwdrivers is only one of many ingenious arrangements that have earned for Popular Science Institute the respect of leading authorities and the confidence of tool buyers.

For hand made samples or production by thousands this *grainless* wood board

A business crisis. New models to build. Samples wanted yesterday and production costs skyrocketing. In just such emergencies industrial executives have turned to Masonite Presdwood, the easily worked, grainless wood board. In your business, too, it may be found profitable. May we send you samples with which to experiment?

FOR KITCHEN CABINETS

In the changing times that demand new methods, for the new competition that requires new products, there is an ever growing industrial need for Masonite Presdwood—with the strength, the lightness, the extreme workability that only this grainless wood board can give.

Skilled mechanics in the tool room, foremen in charge of big punch presses, find nothing in Presdwood to dull keen tools or wear out dies before their time.

For Presdwood is just clean wood that is blown apart and then pressed together, under tons and tons of pressure.

Because Presdwood does not warp, crack, split or buckle, there are no costly rejections in final inspection. And because it comes in ⅛th and 3/16th inch thicknesses and in standard 4 foot by 12 foot boards, there is almost no waste to boost production costs.

Resists Moisture ~ Takes any Finish

These grainless boards are smooth as glass on one side and textured like canvas on the other. The smooth hard surface with its delicate brown shading is naturally beautiful. The material resists moisture and requires no paint for protection. It can either be left in its natural state or finished to represent the finest type of natural wood.

FOR PUNCH PRESS OPERATIONS

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Our Readers Say—

What's Your Opinion

SINCE the recent publication of George S. Greene's articles explaining famous tricks of magic, POPULAR SCIENCE MONTHLY has received scores of letters from professional and amateur magicians, protesting against such an expose of the secrets of their art.

The following extracts from a letter from Howard Thurston, dean of American magicians, are typical.—*The Editor.*

"I beg of you not to destroy the charm and value of one of the oldest arts in the world—magic. Your expose of magic will do greater harm than you can imagine, and I am sure POPULAR SCIENCE has no desire to injure any individual or art.

"A trick explained has lost its value, both to the magician and his audience. The magician's loss is incalculable; the spectator loses interest and the pleasure of the mystery. No good has been done, and only harm to the performer and his audience.

"A costly trick robbed of its mystery becomes valueless. The writer has frequently spent thousands of dollars in perfecting an illusion. If you reveal the mystery there remains no value.

"I appeal not only for myself, but for thousands of other devotees, many of whom earn their living with magic. There is as much justice in permitting these articles to change our valued secrets to worthlessness as there would be for some one to change your valued gold watch to brass.

"Three of the tricks you expose are features in my performance—catching goldfish and pigeons from the air, also the Levitation. I purchased the exclusive use of this illusion from Mr. Harry Kellar twenty-two years ago, and it has been a feature of my performance ever since.

"It is a question of justice and honor, and as a public entertainer I appeal to your honor as a publisher not to destroy our art and livelihood, nor deprive the public, including the millions of children, of the romance of the mystery and wonder of magic.

"The world needs magic, and I beg of you to accept the plea of many thousands of devotees, all of whom will be grateful to you and POPULAR SCIENCE."—HOWARD THURSTON.

Dangerous Goldfish

"YOUR article 'Strange Fires that Start Themselves' was excellent. But you failed to include one of the strangest causes, about which I think most people should be warned, as it is liable to happen in almost any household; namely, the setting fire to furniture or household hangings by the rays of the sun focused through round water bottles of glass, operating accidentally as burning lenses.

"Here in England this cause has become common enough to elicit a formal warning from the London County Council. There was one instance here in which a fire was started by the condensation of solar heat through a round, water-filled bowl in which the family goldfish remained swimming quite happily and unhurt while their water-filled home performed its incendiary task. Don't you think this is a sufficient fire hazard about which to warn your readers?"—L. C. A., London, England.

Hope You're Wrong

"WHY does POPULAR SCIENCE MONTHLY try to make people believe that science is 'romantic,' 'amazing,' 'dramatic,' and so on?

"Believe me, you're not fooling anybody. Everybody knows science for just what it is—dry as dust, heavy as lead, and dull as an ashman's shoes. I don't see where POPULAR SCIENCE fits in the present age, anyway. People are only interested in entertainment, money, and sex."—N. A. B., Dayton, O.

Why Not Wear Rubbers?

"PLEASE add this to your list of "What's Wanted" inventions—a device, like the electric machines used to dry hands by a blast of warm air, to be installed in shoe shops to dry wet feet in a few seconds during the slushy winter months."—A. R. W., Hartford, Conn.

Let 'em Stay Dumb Then!

"OF ALL the cruelties, I can think of nothing more heartless than wishing human attributes (including brains) on happy dumb animals, as Robert E. Martin attempts to do in 'New Proofs that Animals Really Think.'

"Mr. Martin, don't you envy the dog—three squares a day for nothing, and a luxurious place by the fireside? And think of the contented cow—chewing her cud and enjoying the indoor sport of flipping a well-aimed tail in the eye of the milker. Which is to be more envied—the squeal of the delighted hog, or the wail of a crying tenor?

"Yes sir, the more I see of dumb animals, the more I am convinced that human brains cause all the trouble. And the more I see of the sum total of human intelligence, the more I admire the skunk.

"Yours for letting the pigs be pigs."—E. D. H., Columbus, O.

Here's a Hot One!

"REPLYING to 'R. N.' of London, I will say that it is possible to plunge one's hand in molten lead without injury. I used to work in a battery repair shop which molded its own lead parts from scrap lead. One day when we had a pot about half full of molten lead, the boss told me he could plunge his hand into the lead without injuring either the lead or his hand. To prove it, he plunged his forefinger into the hot lead. He waited, however, until the lead was considerably hotter than its melting point, for fear, probably, that some would harden onto his finger and burn him. And he didn't leave his finger in the lead more than the smallest fraction of a second. As 'R. N.' suggests, his skin was tough, due to having more or less acid on it all the time."—C. W., Lockhart, Fla.

A Useful Short Cut

"SOME time ago I had a really practical mathematical 'short cut' called to my attention. I have used it a great many times and have found it speedy and accurate. This system permits the dividing of a mixed number, the whole number being odd, by two, without reducing to fractions or carrying over the customary fraction from the divided whole number.

Example: To divide $13\frac{15}{16}$ by two:

Process: Half of 13 is $6\frac{1}{2}$. Eliminate the $\frac{1}{2}$ and we have 6. Now add the numerator and the denominator and we have 31. Double the denominator and we have 32.

The 6 becomes the new whole number, the added numerator and denominator becomes the new numerator, and the doubled denominator becomes the new denominator, hence we have as a result: $6\frac{31}{32}$

It will be noted that this system applies only when the whole number is odd. The dividing of even numbers with fractions is well known to everyone. I hope that this may prove of interest to your readers."—R. W. A., Flint, Mich.

Which Railroad Is This?

"I HAVE just read the letter from S. T. R., Jr., on the Wright brothers, commenting on their contribution towards increasing the death rate. I am a railroader, and in my spare time am a student pilot, and I feel safer when I am flying than I do on my regular job.

"Records show that ninety percent of our air accidents are caused directly by carelessness and poor judgment on the part of the pilot, and I am convinced that most of the other ten percent are due to the same cause.

"Every case of structural failure I know of was caused by excessive stunting shortly before (except in the case of obsolete war-time ships). It is possible to pull the wings off the best plane built, by holding it in a power dive and pulling it out sharp enough. A fool will always break his neck if you give him rope enough, and Heaven does not protect him just because he is in an airplane."—R. M. N., Marquette, Kas.

More Fun for Father

"PLEASE accept my congratulations upon the interesting article relative to model railways by Mr. F. D. Ryder, Jr. I believe that there is a fine field here which has been neglected by both publishers and model railway manufacturers. As suggested by Mr. Ryder, children, and incidentally grown-ups, very soon tire of watching a train go round and round a circular track. However, if efforts were made to demonstrate that a toy can be created in which interest may be indefinitely sustained and which is a constant stimulus to the creative instinct, there would be a great increase in enthusiasm for this really splendid toy."—T. C. L., Washington, D. C.

Men who "know it all"

are not invited to read this page

THIS page is not for the wise young man who is perfectly satisfied with himself and his business equipment, who believes that the only reason he is not paid twice as much is that he has never been "given a chance."

This page is a personal message to the man who has responsibilities, who feels secretly that he ought to be earning several thousand dollars more a year, but who simply lacks the confidence necessary to lay hold on one of the bigger places in business. We should like to put into the hands of every such man a copy of a little book that contains the seeds of self-confidence. It is called "Forging Ahead in Business," and it is sent without obligation.

We have in mind, for example, a certain man who is now auditor of a great corporation in the Middle West. Until he was thirty-one years of age he was a bookkeeper. His employers had made up their minds that he would always be a bookkeeper. His wife was beginning secretly to wonder. Worst of all, he himself was beginning to lose faith.

He sent for "Forging Ahead in Business." Without any great hope in its results, he enrolled for the Institute's training.

The first few months of his association with the Alexander Hamilton Institute were a revelation to him. He found himself being initiated into fundamental principles of business that had hitherto been a mystery to him.

He began quietly to make suggestions to the officials—suggestions that surprised them, because they had ceased to expect anything from him. They revised their estimate of his capacities; when the position of auditor became vacant, he was given his chance. And recently on an important financial problem, he argued against the position of the company's own attorneys—basing his arguments on principles which the Institute had taught—and by proving his point succeeded in saving the company $60,000.

The self-confidence that the Institute gave him has transformed that man. He will be a vice-president of that great corporation, and at 31 he was condemned to be a bookkeeper for life.

Thousands Could Double Their Incomes

For the man who is perfectly content with himself and his job the Alexander Hamilton Institute can do nothing. But there are thousands of men who could double their incomes in one year if they believed in themselves and had the solid business knowledge to back up their belief.

To such men the Institute offers "Forging Ahead in Business"—which describes clearly and interestingly what the Institute can do for you. Thousands of successful men regard it as one of the most valuable little books they ever sent for. May we send it to you? The coupon is for your convenience.

Announcing Three New Management Courses

The rapid developments in modern business have brought increasing demand for an extension of Institute service.

To meet this demand the Institute now offers three new Management Courses in addition to its regular Modern Business Course and Service. These are a Course and Service in:

1—Marketing Management
2—Production Management
3—Finance Management

These new Courses are of particular interest to younger executives who want definite training in the management of the particular departments of business in which they are now engaged.

The details of this interesting development in business training are included in the booklet which the coupon will bring you. Send for it.

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HOW much better it is to think of insulation *before* you build or buy than to be reminded of it *later* by wasteful heat-leakage; dampness, chill and draughts!

And how quickly you realize that uninsulated houses are out-of-date when you visit homes that *resist* the passage of heat . . . that help keep furnace warmth *inside* during winter and scorching sun heat *outside* in summer!

Celotex, more than any other material, brings these advantages of insulation to American homes. It saves 25% or more on fuel bills; protects health and increases comfort all year 'round.

As a heat-stopper, Celotex is three times as effective as wood, eight times plasterboard, twelve times brick and twenty-five times concrete. Its effectiveness is proven by the fact that it is used in thousands of refrigerator cars and household refrigerators, as well as in more than 250,000 homes.

Celotex is the only insulation made from the long, tough fibres of cane. It comes in big, strong boards, 4 feet wide, 7 to 12 feet long and 7-16 inch thick. These boards withstand all kinds of weather and add structural strength to buildings when used as sheathing.

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As interior finish, Celotex adds new beauty to homes through its natural tan color and delicate fibre texture.

And for plasterbase there is Celotex Lath 18 inches by 48 inches, and 7-16 inch thick. It is especially designed to reinforce against plaster cracks and eliminate lath marks . . . to give finer, smoother plastered walls.

Ask your contractor, builder or architect for further information on Celotex—and send in the coupon below for our free booklet.

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Popular Science MONTHLY

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I Am Learning *to* Be a Flyer

By LARRY BRENT

A typical American youth who long has wanted to break into aviation

I STOPPED with my hand on the door knob. Would that doctor find me physically fit?

For years I had pictured myself zooming across the sky in a mail plane or a passenger plane, or writing letters of smoke a mile high. Since leaving high school I had saved enough money to pay for the course. I had convinced my doubting parents that I had chosen the career for which I was best fitted. What a job that had been! Finally, I had been assured by a Curtiss Field official that I would be welcome—if the doctor found me physically fit.

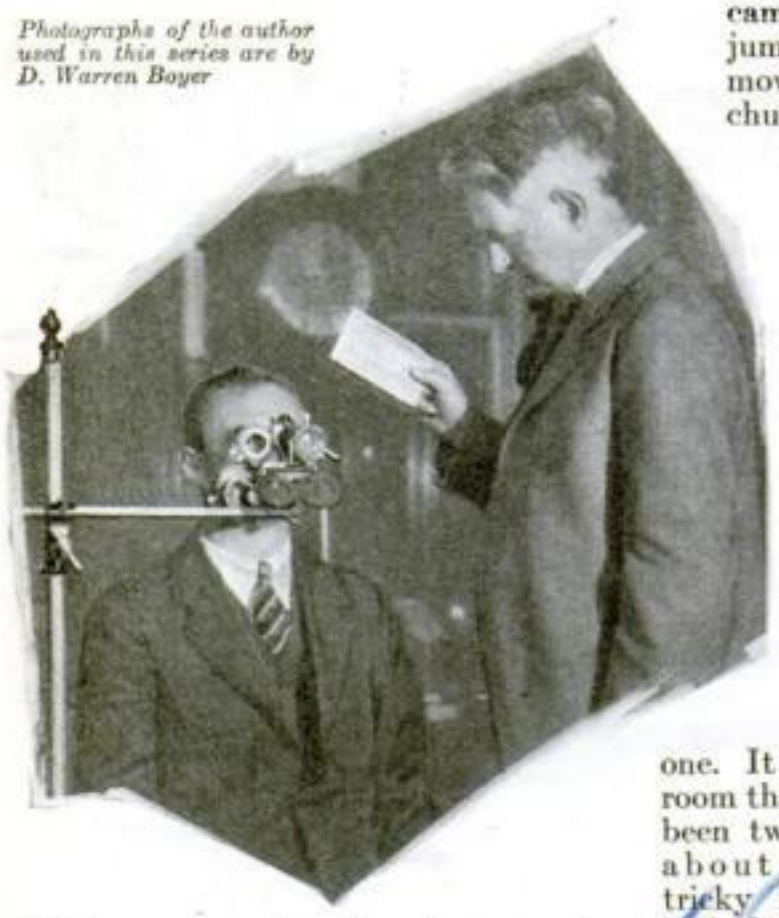
For three years I had planned, worked, and saved to become a flyer. But was I fit? Were my eyes all right? Was my sense of this and that all right? How did I know? A student I had talked to at the field had stirred up those doubts. He had said that the examination was a terror.

"You don't go to an ordinary doctor," he had said, "but to one appointed by the Department of Commerce. There are only five or six of them in New York City. They test you with all sorts of tricky little machines. You certainly have my sympathy."

When I opened the door, I needed a lot of sympathy. I felt wabbly in the knees, queer in the stomach; my heart was racing; my hands and feet were cold, and I was perspiring.

A young woman was seated at a desk. Behind her, on the wall, were signed

Photographs of the author used in this series are by D. Warren Boyer



Testing my eye muscles with a phorometer, to measure ability to adjust eye focus quickly.

photographs of famous flyers. Would my photograph ever join that collection? I gave the girl the slip of paper that had been given to me at the field. It read:

WILLIAM J. FRANCIS, M.D.
121 Madison Avenue,
New York, N. Y.

Introducing.....Larry Brent
Referred by
Curtiss Flying Service, Inc.
Remarks.....Student

The girl said, "Your appointment is for four-thirty, Mr. Brent. Dr. Francis will be free in a moment." Then she began firing questions and writing my answers on a long form. My full name?

"Lawrence Arthur Brent."

Permanent address? "Bridgeport, Connecticut."

Place of birth? "Bridgeport."

Date of birth? "May third, 1906."

Age next birthday? "Twenty-three."

Weight? "A hundred and eighty."

Height? "Six-feet-two."

The girl smiled and said, "Most flyers are tall. Your hair is blond and your eyes are blue, aren't they? What education have you had?"

I told her I had graduated from high school. I signed the form she had been filling in and looked up to see a man with gray hair, gray eyes, and a flowing black bow tie standing in the doorway.

The girl said, "This is Lawrence Brent, doctor. He has an appointment for a student flyer's examination." Dr. Francis shook my hand. His hand felt warm and dry. Mine must have felt cold and clammy. He asked if I'd ever flown. I said I had not.

"Never been up in a plane?"

"No, sir."

"Why do you want to fly? Adventure? Thrills?"

I said I had wanted to become a flyer ever since I was a kid.

"Not since Lindbergh flew to Paris?"

"No, sir, I was making working models of every new plane that came out when I was twelve. I jumped out of my grandfather's haymow with an umbrella for a parachute when I was ten."

"Hurt yourself?"

"I sat down pretty hard."

He smiled. "What have you done since leaving high school?"

"I worked on a newspaper, reporting."

"Saving your money?"

"Yes, sir, enough for a twenty-five-hour course. I want to go on from there and become a commercial pilot."

"Then you want the transport examination."

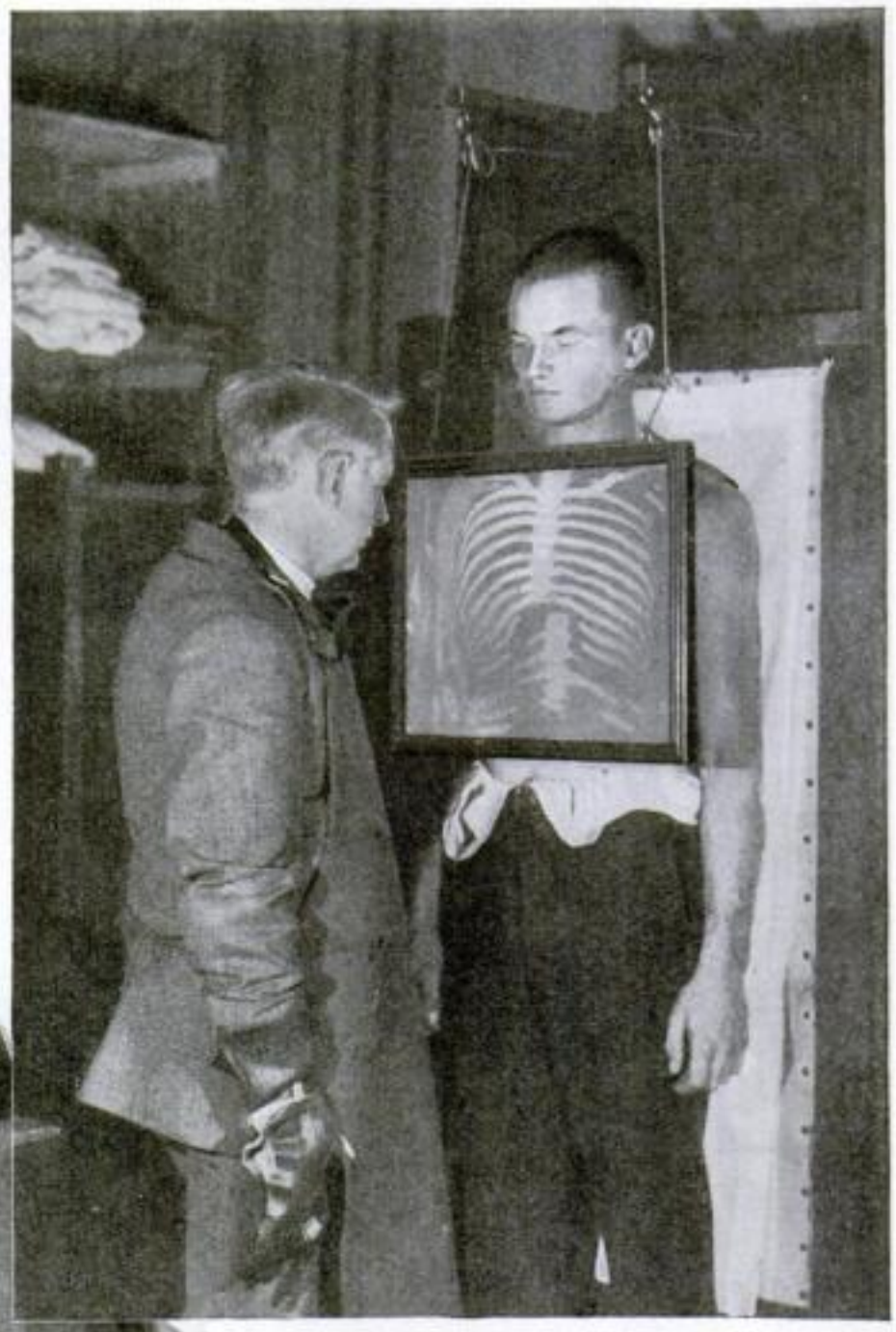
"Yes, sir."

"Follow me."

My heart gave another and higher jump. We went through a small room and into a large one. It was furnished more like a living room than a doctor's office. It must have been twenty-five feet square. I looked about for the tricky machines I had heard about. But I saw only one strange-looking piece of apparatus. It stood on four long black legs against the wall. It resembled a tiny stage on stilts; my heart sank as I looked at it, as though it were a gallows. On the wall behind it were some optical charts. At the other end of the room a woman in white sat at a mahogany desk.

A worried-looking man of about thirty with nervous black eyes came in, whispered something to the doctor, and walked out. I learned later that the black-eyed man wanted to fly but was physically unfit—blood pressure too high. He had returned again and again, but always his blood pressure flunked him. Infected tonsils, Dr. Francis believed, were causing it. The black-eyed man was going to have his tonsils out—and return again.

I LEARNED that applicants often fail because of some defect which can be remedied. When it is remedied, they can obtain the doctor's O. K. to take flying lessons. Twenty-five of every hundred applicants fail to pass the physical examination. Of those who do pass, only about one tenth ever learn to fly. The others lack something, perhaps courage, perhaps flying instinct, which no machine can test. I estimated, from these figures, that of every hundred men who came to Dr. Francis for a physical examination, only about seven become flyers. The odds against me were ninety-three to seven. I had a right to feel scared!



Dr. Francis backed me against an X-ray machine and looked at my heart and lungs on the screen.

Testing my judgment of distance. Pulling the strings moved one of the rods shown on the opposite page.

"Sit down in that chair," said the doctor. The chair was beside the desk. The woman in white was his technician and assistant. She picked up a pad of tan tickets and said, "Your number is 922." She began asking questions in a soft, low voice, as if she were trying to put me at ease, and wrote down my answers on a form much larger than the one the nurse had used.

Had I ever had rheumatism, asthma, malaria, and so on? No. How much

alcohol did I use? Did I ever take drugs? By drugs she meant medicines as well as habit forming drugs. No; I never took medicine unless I was sick in bed. The technician explained that people who took medicine all the time were apt to be nervously unbalanced—wouldn't stand the gaff of flying.

Had I stammered as a growing child? No. Did I have dizzy spells? No. Did I or had I ever had convulsions? No. Did I have headaches? No. Did I walk in my sleep? No. Then she shot at me: "Do you remember when you fainted last?"

"I never fainted in my life!"

AFTERWARD I asked her why she had asked those questions. What had they to do with flying a plane? They were to determine, she told me, whether I was or had ever been epileptic.

"How do you feel when you look over the side of a high building?"

I hesitated. This sounded tricky. I told the truth: "Dizzy."

"So do most flyers. How is your memory?"

"Pretty good. I remember faces but sometimes forget names."

"Ever find yourself in a place and wonder how you got there?"

"Never."

If my answer had been yes, I would have been an amnesia victim. It wouldn't be very healthy for a pilot to find himself a mile up in the air and wonder how he got there!

There were other innocent-sounding questions. Did I worry about anything? I told her I was worried right now about passing this examination.

"So are ninety-nine out of every hundred applicants. The man who isn't scared is apt not to make a good flyer. Too insensitive." While I was puzzling over this she shot another fast one: "What are you afraid of?"

"Snakes!" I blurted.

She laughed. "What kind of disposition have you?"

I said I didn't know.

"Are you up in the clouds one minute and down in the depths the next?"

I wasn't and said so. Dr. Francis chuckled and said, "Disposition—amiable." I didn't know he'd been standing there all this time. I didn't realize that not only my answers to all these questions but the *way* I answered them comprised a psychological test. The technician and the doctor were trying to find out what made my wheels go. What interested me at the moment was that everybody who came to be examined was as scared as I was. Dr. Francis said:

"Even great flyers when they come here for their semi-annuals are scared. Floyd Bennett was always afraid he would not pass the eye test, although his eyes were excellent. When he started for this office he would try to read every sign on the street, no matter how small or far away. He worked himself into such a state that when he arrived here he felt sure he could hardly see anything. But his eyes always passed every test."

I asked him if many flyers failed on their reexaminations. He answered: "No. A few old-timers who flew before the Department of Commerce took charge of physical examinations have defects which would prevent them from getting a license if they were starting now. These men have developed compensations. If they have good records they can often obtain waivers from the Department of Commerce, so that they can continue flying. Cross your knee, please."

I crossed it. The doctor picked up a little hammer with a wedge-shaped rubber head. He tapped just below the knee and my leg kicked up slightly. "Now the other one." That leg, when tapped, kicked up a little, too. My reflexes were all right.

"Stand up. Put heels together and toes together. Close your eyes."

I did so. "Now stand on your right leg and close your eyes."

I obeyed. My nervousness made me feel wabbly. I wabbled a little—but didn't lose my balance.

"Now fifteen seconds on the other leg."

When I had done this he had me walk down a white line in a rug with my eyes closed, then backward to where I had started from.

The doctor asked me if I'd ever heard of the whirling chair.

"Yes, sir. Do I take that next?"

"You don't take it at all. The tests you've just finished take the place of the whirling chair. We find out more about a man's sense of equilibrium by having him stand on one leg and then the other with eyes closed than we did with whirling chairs. You walked the white line with eyes closed to show us whether or not you have locomotor ataxia. You haven't. We have found out that your semicircular canals are functioning normally and that your nervous and muscular response to them is normal. The semicircular canals are part of the inner ear. They're filled with a liquid and work on the same principle as a carpenter's spirit level. When you grow old the liquid thickens and your sense of balance becomes poor. Old men make poor flyers. Their muscular response to upset balance is too slow. Turn your chair around, please."

WHEN I was facing the other way, he placed a black disk over one eye and told me to read off the letters on the chart at the end of the room. It was twenty feet away. I could read all but the bottom line of letters with each eye.

"Twenty-twenty for each eye," he said to the technician, (*Continued on page 176*)

When I had stripped, Dr. Francis took my blood pressure and pulse. I was afraid my pulse was much too high. And it was! But so is that of everyone who takes the physical examination.

Brilliant Series

The other day I wrote a letter to Mr. Brent in which I said:

"Your series is the most brilliant description of a pilot's training ever written. It's brilliant because it's real. As I read I could almost hear the pounding of the motors and the whir of the propeller. I feel sure that every one of our readers is going to share the thrills you are having. Congratulations!"

And this is what Mr. Brent replied:

"Thanks for the kind words. If readers of POPULAR SCIENCE MONTHLY get just a little of the kick I'm getting out of learning to fly, I'll be satisfied."

Step by step Mr. Brent will take you through his course. My advice is not to miss a single installment.—The Editor.

The apparatus for testing judgment of distance—two upright rods, one of them movable. Dr. Francis pushed the movable rod to the front or rear. Then, pulling the strings in my hands, I moved the rod back and forward until it appeared to be exactly opposite the stationary rod.

How They Sank and Saved the *S-4*

By WILLIAM W. MOSS, JR.

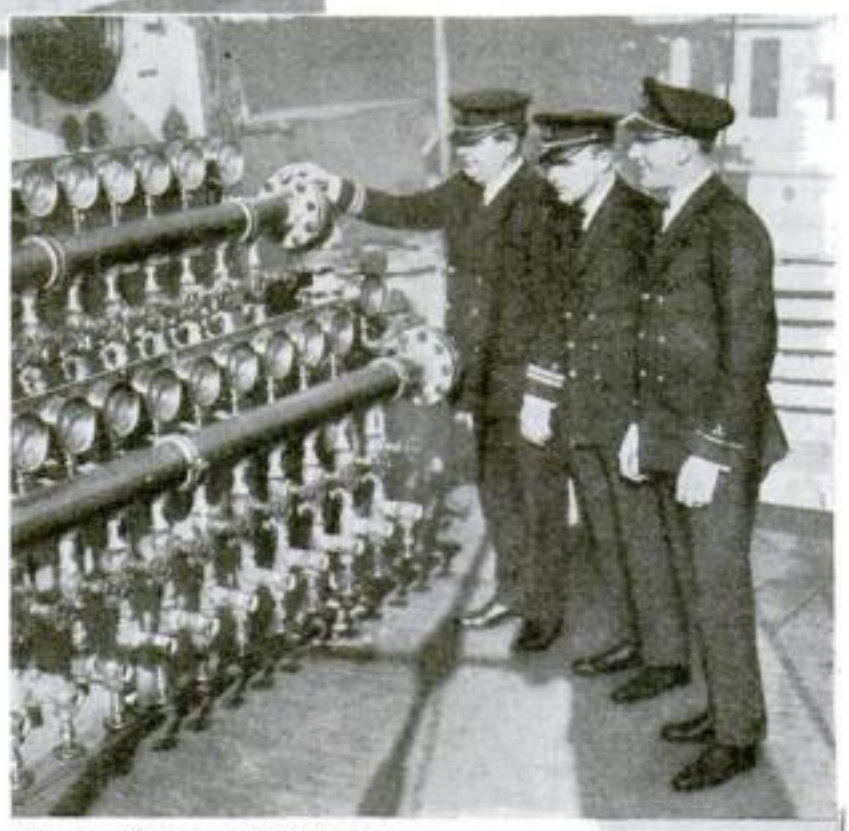
It may mean life to him. Here a member of submarine crew is grasping one of the iron lifting rings fastened in *S-4*'s hull.

ONE cold, bleak early morning recently I stood on the unprotected bridge of the *U.S.S. Chewink*, mine layer and sweeper, as she bored her blunt nose into the fretful waters off Block Island. We had left the submarine base at New London, Conn., for the bay that had been selected as the scene of experiments by which naval experts are trying to make the seas safer for submarines.

There were two of us on the bridge—Lieutenant Joseph A. Rasmussen, the *Chewink's* commander, and myself. The sharp wind that had sprung up at dawn bit right through my heavy ulster. My teeth chattered.

Gliding past the last of the black-and-red channel buoys, we sighted the *U.S.S. Falcon*, Navy salvage vessel, dead ahead. Beside her lay the 233-foot steel cigar that was the submarine *S-4*. I say "was" advisedly, for the *S-4* is no longer an undersea fighter. Today she is a floating laboratory. Once an undersea coffin, the Government dedicated her to a series of tests, of which I was to witness the first, calculated to find ways of rescue when a submarine meets with accident far down in the sea.

My eyes strained against my binoculars, I tried to pick up the details of the famous pair. A ship from which men dive must remain stationary regardless of weather, and so the *Falcon*, as usual, had laid out four 8,000-pound anchors. Stout chains were attached to the anchors, and these, in turn, to buoys. From the buoys, eight-inch manila rope led starboard and port to the *Falcon's* forward and after chocks, and there were fastened to winches. By slacking on one rope and hauling in on another the salvage ship was able to pull herself into any position inside the square marked by the anchors. On the submarine, at least a dozen men were moving in apparent confusion.



Naval officers aboard the salvage ship, inspecting compressed air machinery and indicators used in sea diving.

Suddenly a voice boomed through a megaphone from the bridge of the *Falcon*.

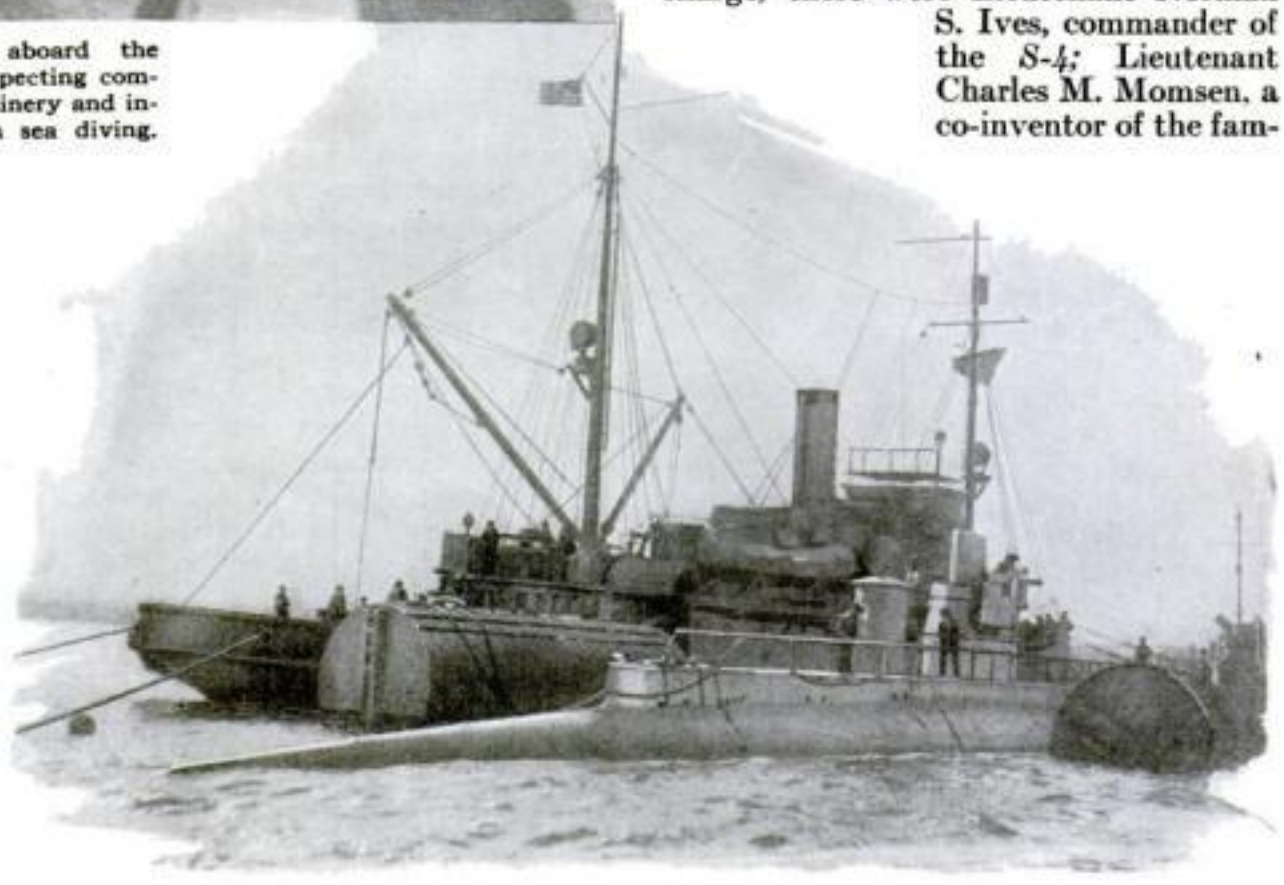
"*Chewink*, aho-o-o-y!" it yelled. "Buoys dead ahead—stand off!"

The warning cry came from Lieutenant Commander Palmer H. Dunbar, officer in charge of experiments. We halted, swung into a wide arc, and dropped anchor. Shortly afterward I was aboard the *Falcon*.

Now I had a chance to observe the *S-4* closely. How unlike a submarine she had become! The big, black gun on her forward deck was gone. The two periscopes, too, were missing. The superstructure of the conning tower had been torn away. Radio mast and aerial also were no more, and aft of the conning tower a circular steel tower, about seven feet high, had been built. This contrivance was the new escape hatch, designed as a means of exit for submarine crews trapped under the sea.

THE submarine lay to the *Falcon's* starboard. She had red buoys attached to each of her ends and a yellow one, with the diver's descending line, in the middle. Long, snaky coils of hose led from the *Falcon* to the *S-4*. On the submersible, these were connected with air compressors. The compressors were to blow out the water, let into the submarine's ballast tanks during the test to sink her. A submarine of the *S-4* type has three main ballast tanks.

Commander Dunbar and other officers explained the details of the forthcoming experiment. Aside from the officer in charge, there were Lieutenant Norman S. Ives, commander of the *S-4;* Lieutenant Charles M. Momsen, a co-inventor of the fam-



The submarine *S-4* riding beside the salvage ship, just after she was brought to the surface in the daring experiment. Between the two vessels may be seen one of the pontoons used in raising her.

ON THE anniversary of the day on which the submarine *S-4* sank with all hands off Cape Cod, salvage experts of the navy recently sank her again. It was a daring, breath-taking experiment, designed to test and prove the latest inventions for preventing recurrence of undersea disasters. Here an eyewitness gives a vivid account of this modern maritime adventure—a thrilling story of seafaring men who pitted science against the waves to save lives in the future.

One of the Navy's expert divers on the salvage ship *Falcon*, preparing to make a deep-sea plunge to the sunken submarine.

Left: The new escape hatch installed on the *S-4*. It provides an under-sea exit for a crew trapped in a sunken submarine.

ous "lung" for divers, and Lieutenant Charleton Shugg, of the naval Bureau of Construction and Repair.

"The test is to determine the practicability of combining pad-eyes and pontoons to lift a sunken submarine," one of the officers told me. "Our hope is to demonstrate a way of sinking pontoons to a point just above a sunken vessel, and attaching them with huge chains to the pad-eyes, great steel rings riveted to the hull of the submarine. Then, by means of compressed air, we mean to blow the pontoons free of the water used to sink them. In that way, we expect to float the pontoons, which should lift the submarine with them."

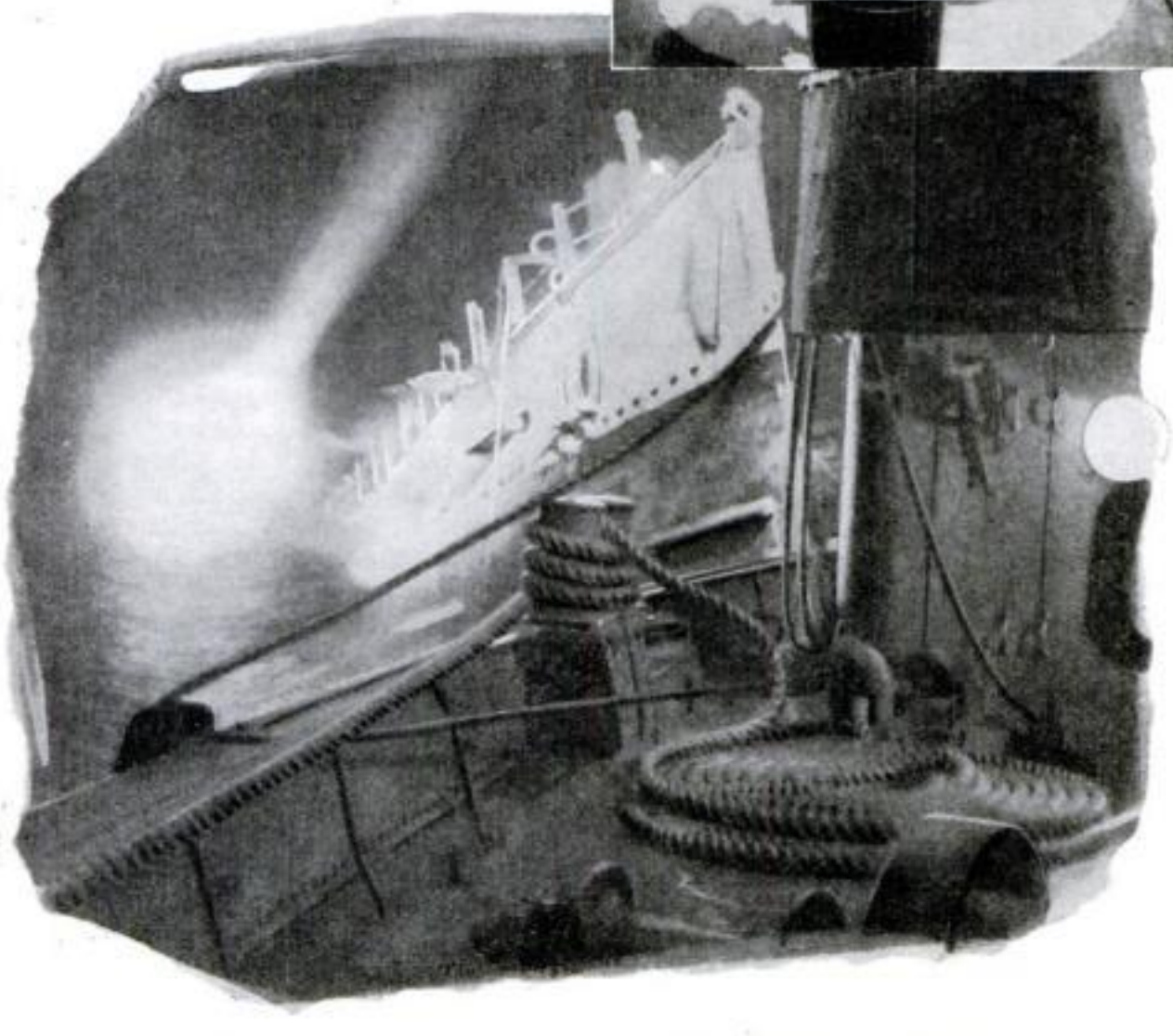
The problem in the past has been to attach chains to sunken submarines. Tragic examples of the difficulty and delay encountered in accomplishing this were the cases of the *S-51*, sunk in 130 feet of water in Long Island Sound after colliding with the S.S. *City of Rome*, and that of the *S-4* herself, rammed and sunk by the Coast Guard Destroyer *Paulding* in 102 feet of water off Wood End, Cape Cod, near Provincetown. Not a soul sunk with either ship was saved. Salvaging of the subs, changed into huge steel coffins, took weeks.

Divers, equipped with fire hose, had to descend to the floor of the ocean, there blast tunnels through the mud and sand underneath the submarine, and then crawl through, dragging ropes after them. These were attached to steel cables which, in turn, were shackled to anchor chains, the links of which weigh ninety pounds each. The anchor chains, fastened around the sunken submarine, were used to lift it. Some idea of the difficulties encountered may be gained from an incident during the raising of the *S-51*, when a diver fell into the hole he was digging with the fire hose. In order to save himself from certain death, he had to turn the stream upon himself and literally blow himself to the surface!

Amid the clamor of public indignation that followed the two disasters and the futile attempts at rescuing lives, numerous suggestions were made. Some were worthless; others plausible. One of them was that pad-eyes would eliminate the anchor chain problem. No tunneling would be necessary, because there would be the big rings to which the diver could attach his chains, and the lifting of a sunken submarine would become a matter of days instead of weeks. Four of them were riveted by straps to the *S-4*, two on each side of the water line, just fore and aft of the conning tower.

It was 8:35 A.M. by my watch when the *S-4* made her experimental dive. The skies were still overcast, the waters choppy. It seemed an appropriate setting for the grim anniversary we were silently observing. For, though no one on the *Falcon* mentioned the fact, we all knew that it was just a year since the *S-4*'s disaster at the bottom of the sea off Provincetown.

Water was let from the *Falcon* into the submersible's ballast tanks. Slowly she began to settle. In fortunate contrast to her tragic (*Continued on page 158*)



The climax of the test—the gray nose of the *S-4* rising from the sea in the glare of floodlights. Slowly it mounted until it reared thirty feet out of the water. This spectacular photo was taken from the salvage ship just as the submarine reached the top.

A WEEK IN THE AIR

By MAJOR H. A. ERICKSON

Army Air Corps, Reserve

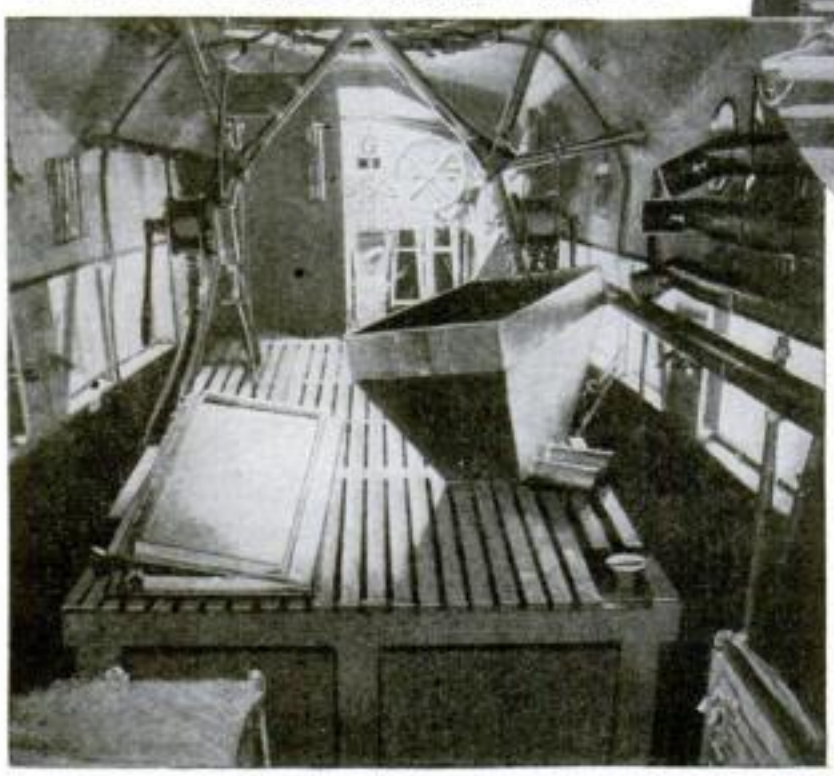
"SHE'S dropping her gas!"

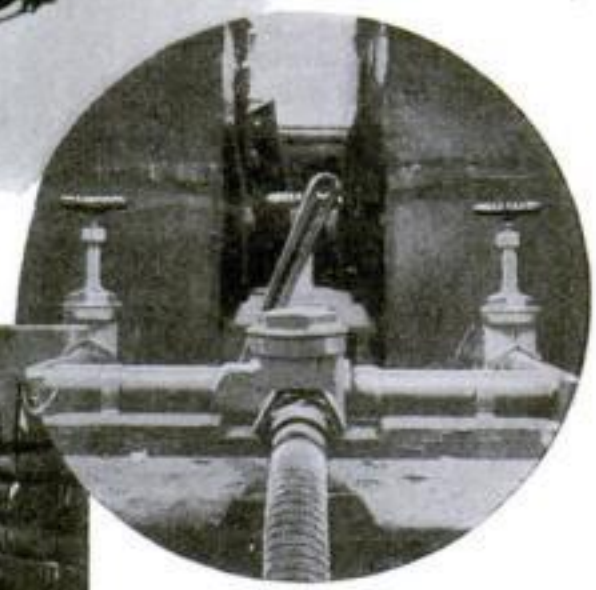
From the great airplane, soaring less than a mile overhead, torrents of gasoline, glistening in the California sun, poured down like sheets of rain in a summer cloudburst. Then the plane glided smoothly out of the sky to a perfect landing on the Municipal Airport field at Los Angeles. It was a large, black-bodied Fokker with yellow wings, on each of which a huge black-and-gold question mark proclaimed the identity of the ship and its heroic crew.

Five men stepped out of the roomy cabin, tired, happy, deaf for two hours to the plaudits of the multitudes that pressed about them. For nearly a week—from a Tuesday morning to the afternoon of the following Monday—they had soared, day and night, in the Army Fokker plane *Question Mark* ("?") to set a new endurance record for all aircraft.

Not once in 150 hours had the rubber-tired wheels of their great plane touched earth. Fed with gas every few hours from a tiny refueling plane, it had surpassed every heavier-than-air craft's mark for endurance, and those of all dirigibles as well. But the machine's amazing mark for endurance had been surpassed by the dauntless Army crew—Major Carl Spatz, commanding officer; Capt. Ira C. Eaker, Lieuts. Harry A. Halverson and Elwood R. Quesada, and, lastly, Staff Sergeant Roy Hooe, charged with the care of the motors.

Refueling the *Question Mark* in mid-air, through a thirty-foot hose dropped by supply plane flying above.





Above: Gasoline hose and petcocks aboard the refueling plane. Left: Interior of the *Question Mark* showing funnel for receiving gasoline supply.

The crew stepping from the *Question Mark* at the end of the record-breaking flight. Left to right: Sergt. Roy Hooe, Lieut. Elwood R. Quesada, Lieut. H. A. Halverson, Capt. Ira C. Eaker, and Maj. Carl Spatz.

For more than six days these men had literally made their home in a spot shared only with the birds and the clouds—three quarters of a mile to four miles above the earth. Even so, they were not wholly isolated from friends and relatives on earth. Fast planes sped between them and the ground, like aerial messenger boys, with telegrams and written notes. Meals were "sent up"—a Sunday dinner, the day before they landed, included such fare as soup, fried chicken, potatoes, fresh peas, celery, ice cream, and coffee. When a pilot wearied he went aft to sleep in a comfortable bed, while one of his fellows took the controls for a turn. Only bitter cold prevented an intended bath for the crew. Even medical supplies were delivered by airplane when one of the crew suffered a minor injury; and a new win- (Continued on page 163)

Setting the Type by Wire!

Latest High Speed Robot Puts the News in Print While It's Sizzling—Why You Can Read about Big Events of the Day Almost As Fast as They Happen

By

JOHN E. LODGE

Why your newspaper tells of the big fight almost while it is happening—in the press box with telegraph and radio.

Soon sports reporters may actually set their stories in type by wire with the teletypesetter, at right.

IN THE year 1438, at Strassburg, Germany, Johann Gutenberg laboriously put beside each other a number of small, wooden, hand-carved blocks. Covering them with a thin film of ink, he carefully placed them in a primitive wooden press, laid a piece of parchment over them, and pulled a lever. When he took the parchment out it bore in Latin the words: "In the beginning God created the heaven and earth." The art of printing, lost with the collapse of ancient Chinese civilization, was rediscovered and introduced to medieval Europe.

A few weeks ago, at Rochester, N. Y., Frank E. Gannett, owner of a string of newspapers, threw the switch of a telegraphic instrument. Instantly, two typesetting machines of the latest and most intricate design, standing across the room, were put into simultaneous motion. Untouched by human hands, each machine began to set type! The latest development of the printing art thus was successfully demonstrated.

More than 100 publishers, editors, scientists, and business men saw a man play upon a keyboard, resembling that of a typewriter, while humming linotype and intertype machines, which a set of electrical resistance coils had placed "140 miles away," actually reproduced words as fast as he could spell them out on the keys!

This marvelous new invention, called the "teletypesetter," eventually may permit one man to set in type the stories of the world's events in the composing rooms of a thousand widely scattered newspaper plants.

It not only will save labor, but is designed to aid in placing news of the day before the public as soon as possible after it happens.

Modern newspapers, especially those issued in metropolitan centers, are complex and efficient organizations. After attending, for example, a major football game in the autumn, you are met as you struggle toward the exit by a shouting newsboy who hands you a still moist and ink-smelly copy of a newspaper containing the score and a detailed account of the contest you just witnessed. If it occurs to you at all to think of the feat performed by the paper it is, most likely, just to say to yourself, "Those newspaper fellows surely do work fast!"

True. But quick and skillful labor alone would not do the trick. The real solution of this familiar mystery lies in the use of every known mechanical device to place the paper at your disposal with the utmost speed. And so the newspapers are watching with tremendous interest the experiments made with the teletypesetter.

How does it work? Come with me to the Rochester *Times-Union* plant, where the astonishing test is in progress. In one corner of a brightly lighted room the sending operator quietly manipulates the keys of a machine resembling an electrical typewriter. Across from him—an electrical distance of 140 or, if you will, 1,400 miles—the two great typesetting machines, untouched by human hands, are whirring smoothly.

As the operator plays his "inaudible tune," the keys on the typesetting machines move quickly, as if pressed down by ghostly fingers.

The customary thing happens in the machines. Little matrices—the brass molds of the letters—drop into their places. Swiftly and noiselessly, levers move and the cast lines of type, each the width of a newspaper column, slide into "sticks" to be assembled later into columns and these, in turn, into pages.

THE operator, punching the keys of his electric typewriter, perforates a tape, seven eighths of an inch wide, each group of perforations corresponding to a letter or numeral. The tape operates the telegraph by sending electrical impulses which, at the receiving end, produce exactly the same perforations in a tape device slightly larger than the sending apparatus. This "receiving tape" takes the place of the linotype operator as it is fed mechanically into the typesetting machine.

As the test progresses, the guests discuss the potentialities of the new printing marvel with Gannett and Walter W. Morey, of East Orange, N. J., its inven-

tor. Gannett declares that the teletypesetter will work more rapidly than an expert linotype operator. And any typist can operate the sending device.

Both at the sending and receiving ends, machines decode the perforations and typewrite them. Thus the sender sees the copy he is wiring and the person in charge at the other end also has a chance to read it. When errors occur corrections can be made.

At present, the process of getting news into type involves the services of at least six persons. The new machine thus would eliminate four workers, besides saving much time.

TIME-SAVING is a consideration of utmost importance to metropolitan newspapers, especially those appearing in the "afternoon"—meaning from nine A. M. until six P. M.—in from eight to fifteen different editions! The paper that first gets news "out on the street" sells most copies. Thousands of dollars are spent to obtain even a minute's advantage in this continuous race to get news to the public first.

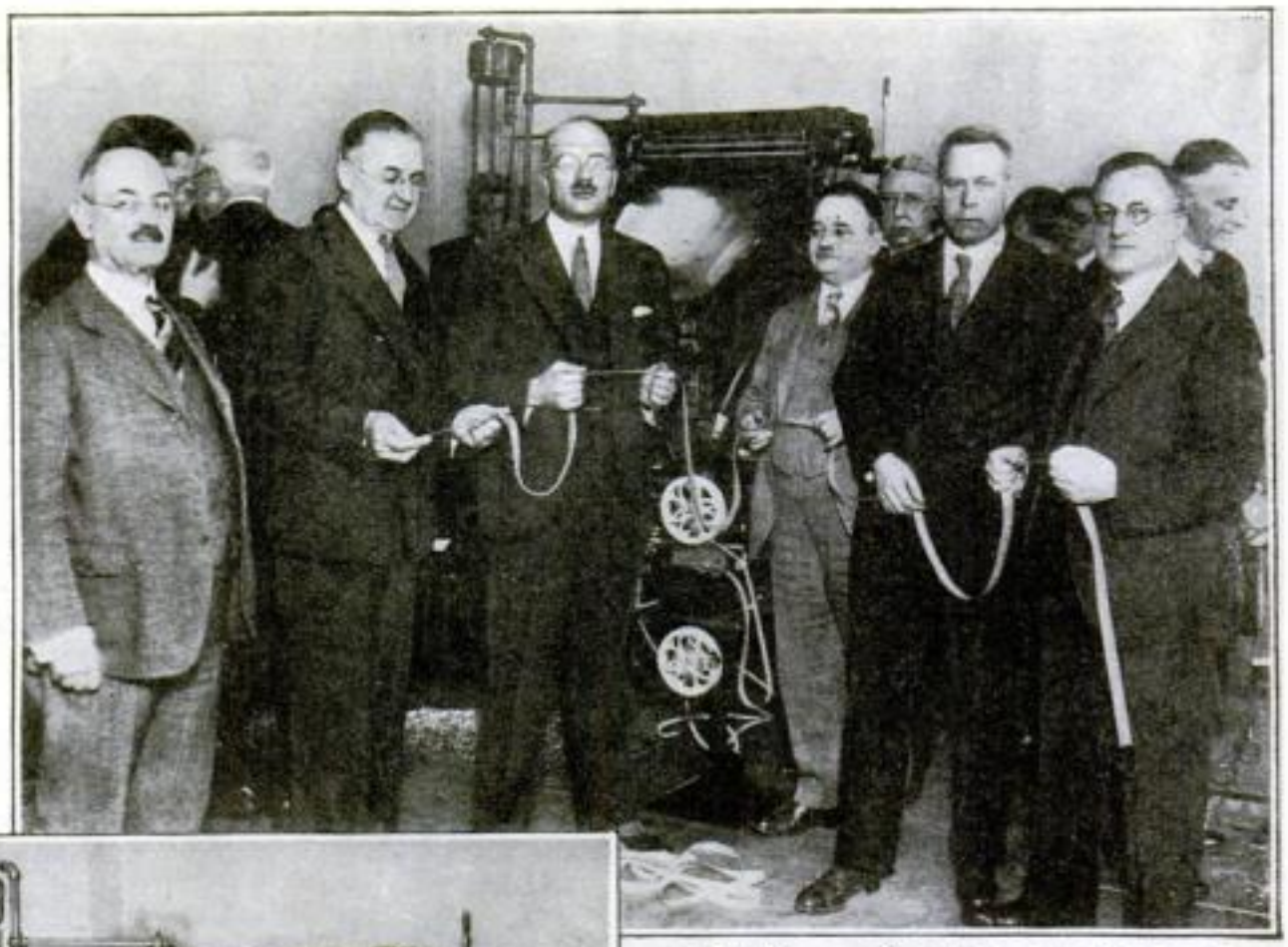
What happens, for instance, in the plant of a great newspaper when details of a world series baseball game are received?

Arrangements have been made for special telegraph wires from the ball park to the newspaper. Because news of the game's progress must appear as quickly as possible after each inning, these special wires are not run to the editorial offices, as usual, but directly to the composing room, where the type is set. Speedy telegraph operators sit at their keys right beside the linotype operators or handsetters. The so-called "running" story of the game is set by machine; the box score by hand.

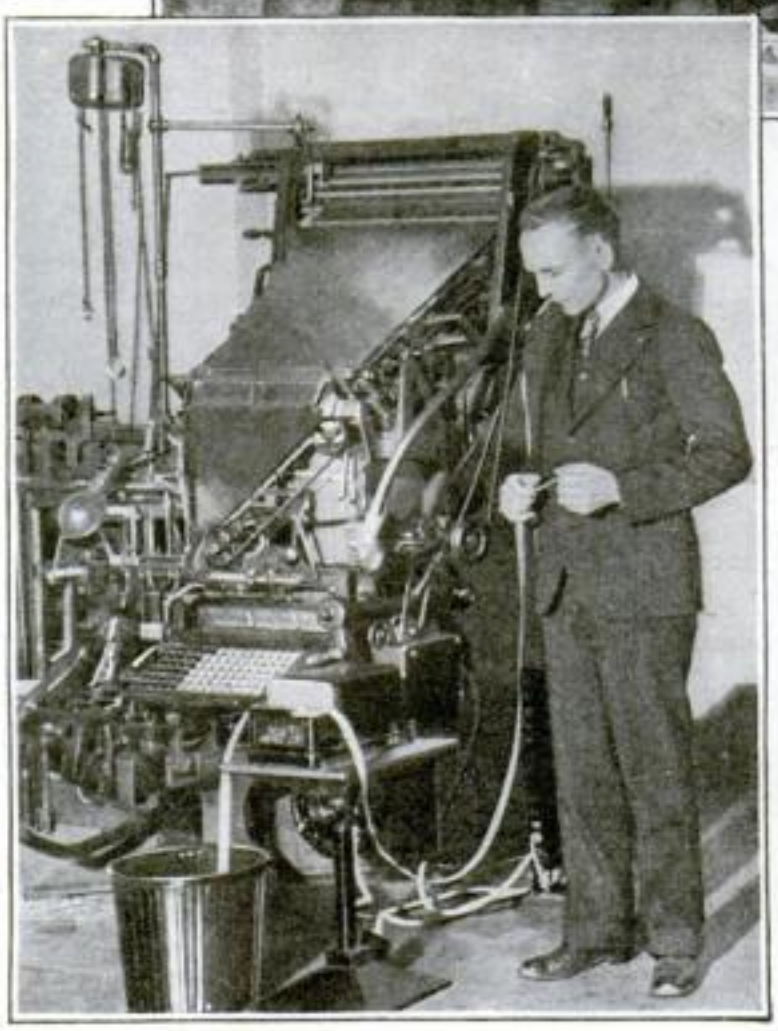
AS EACH player goes to bat, the writer in the ball park dictates the plays to a telegraph operator by his side. The operator flashes it to the newspaper office. The telegrapher at the receiving end quickly translates the Morse code on his typewriter. He then passes the copy to the sports editor, who has left his customary domain to make his temporary headquarters in the composing room. The editor reads the copy. He checks up his box score, then hands it to the typesetters. These put in the type, changing the score and running story continually as the game progresses.

Meanwhile, the sports editor writes the headlines, changing them as the plays demand. Thus score and story are kept right up to every play and, in the last inning, the "third out" completes the box score and it is only a matter of minutes to send the paper to press.

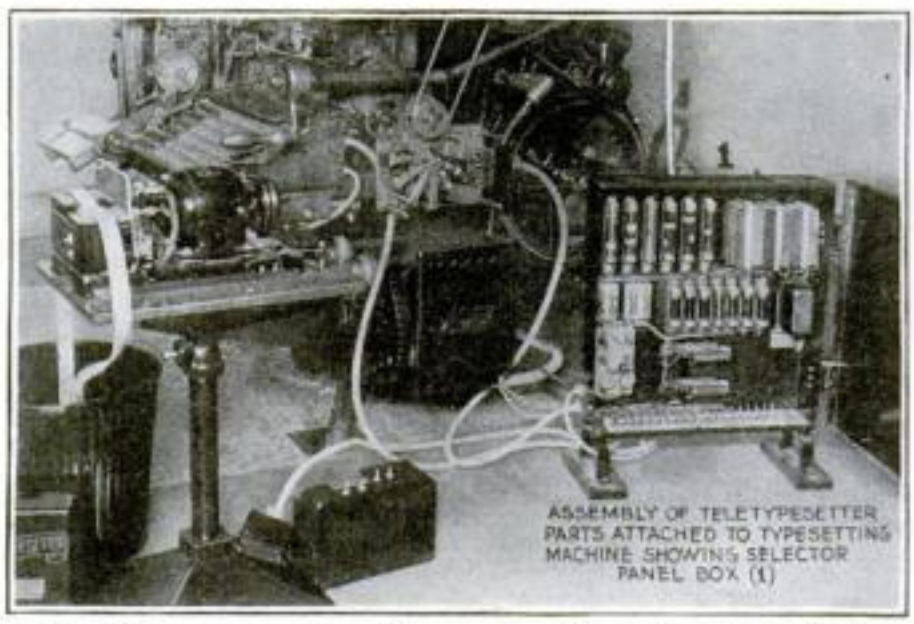
The same elaborate preparations and processes prevail in covering football games, prize fights, and all other fixed events of public interest. Few newspaper readers are aware that reviews of plays, concerts, and operas are sent into the newspapers by telegraph.



Publishers and engineers examining perforated tape which replaces linotype operator as it is fed into typesetting machine. Walter W. Morey, the inventor, is at extreme right.



With a linotype machine automatically clicking type into print, the editor studies the news on a perforated tape.



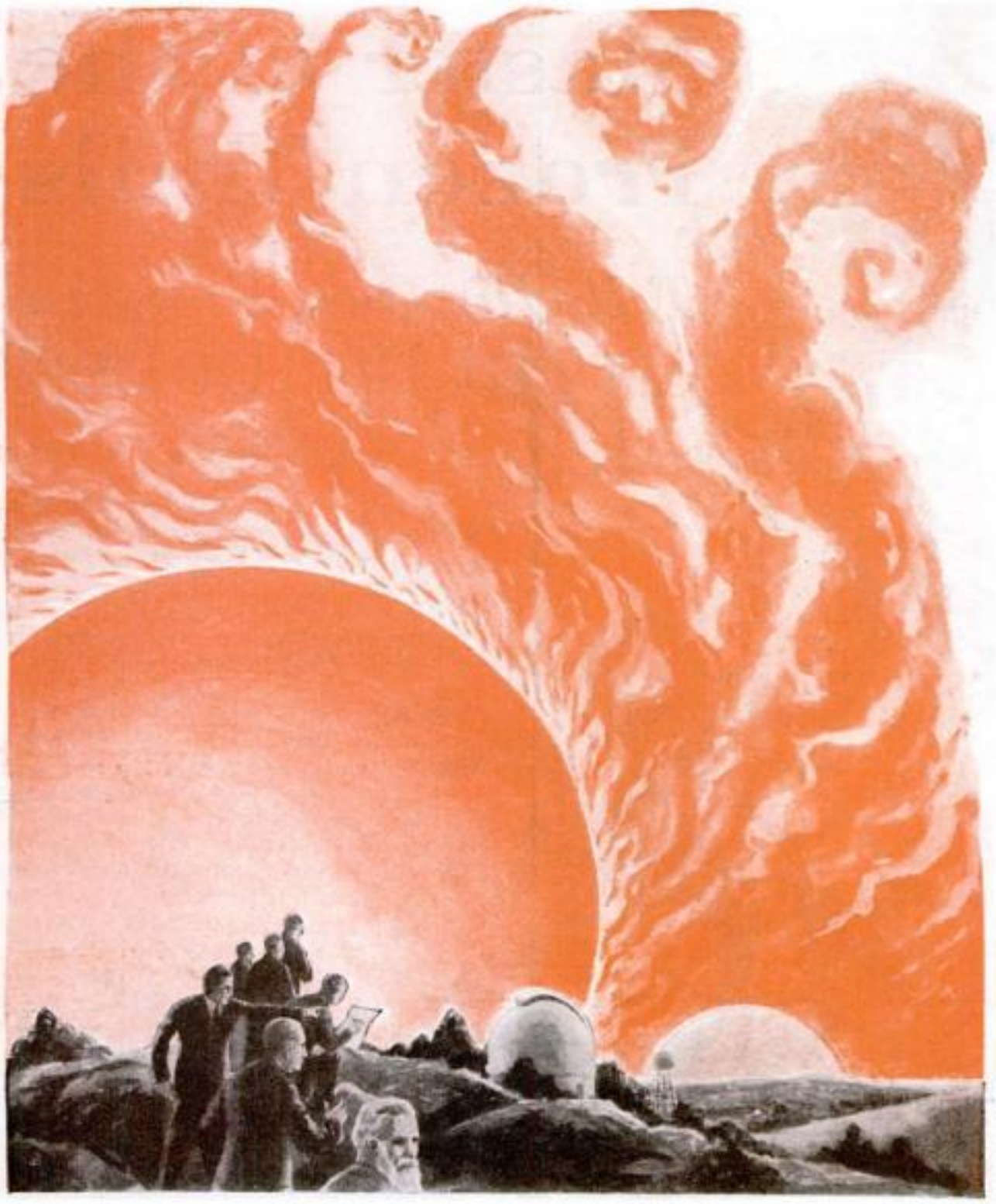
Receiving apparatus for setting type by telegraph. Eventually it may permit one man to set type in scattered newspaper plants.

In New York some of the newspaper plants are located in the old downtown section, too far from the theatrical district to permit reviewers to return to the editorial offices after a play or opera, so the critics "file" their articles by telegraph. The same conditions are responsible for the fact that newspapers sometimes have printing plants at as many as three strategic points in different parts of a city, to which duplicate and triplicate type molds are rushed from headquarters before each edition, and whence the papers are distributed at top speed.

THE newspapers, always quick to avail themselves of the latest advances in science and invention, realized early that radio was to play a big part in the dissemination of news. Most metropolitan dailies today possess high-class radio receiving equipment. Do you remember noticing, during the last Presidential campaign, the line: "The following is a complete stenographic report of the address made by Senator So-and-so at this afternoon's session of the Houston Convention," and wondering how it was possible for your favorite newspaper to be out on the street with a full verbatim report of the speech about the same time the particular session closed?

Well, this is how it was done: The paper placed stenographers in relays before the radio receiving set and made them take all announcements and speeches verbatim. The relays consisted of from six to eight girls taking only 500 words at the time. While their colleagues relieved them at the loudspeaker, the stenographers typed the copy, which in this manner was placed in front of the editor, "copyread," headed, and printed by the time the session came to a close.

When the Sun Grows Cold—



While scientists watch, the furnace of the sun slowly burns itself out. But its shattered atoms, hurled into space, return as energy in the form of electrons for a new sun to supply heat for future ages.

"A NEW one will be born!" says the famous discoverer of cosmic rays. Here Dr. R. A. Millikan tells of the future fate of man on earth. If you've ever wondered where we are going, and how long our little planet will last, you'll read with unusual interest this interview with a great American physicist.

By
FRANK PARKER STOCKBRIDGE

"WHEN the stars grow old and the sun turns cold," what will we of the earth turn to for our supply of energy? A question which fascinates scientists as well as laymen and stirs the imagination by possibilities it opens up.

"Grow a new sun!" is part of the startling answer of Professor Robert A. Millikan, of the California Institute of Technology. By the time the human race needs it he believes we shall have another sun to draw energy from and, meanwhile, we may have learned how to capture and harness the energy of cosmic rays poured upon the earth from interstellar space!

When Millikan speaks, the world of science takes notice. Winner of the Nobel Prize for his work with electrons, regarded as one of America's two foremost physicists and one of the half dozen great interpreters of science today, he commands the respect of his fellow-scientists. When I met him at the annual assembly of the National Academy of Sciences I was much interested to observe the deference which every scientist present paid to his opinions on every topic discussed.

That's why I asked him what he thinks about the universe. Where are we going here on earth, how fast are we traveling? How far have we come and how long shall we be on the way? And this is what Millikan thinks:

"We have learned within the last half-dozen years," he said, "through studies in radioactivity, that this world of ours has in all probability been a going concern, in something like its present geological aspects, for more than a thousand million years, and hence that the human race probably can count on occupying it for a very long time to come, say another billion years.

"Disasters that can befall mankind merely because of erroneous conceptions of the nature of the world in which we live are well illustrated by the historic record of miseries that came upon the earth in A.D. 1,000 because of the widespread belief that it was coming to an end at that time," he said. "I venture the estimate that the knowledge that man probably has another billion years ahead of him, in which there is a possibility of his learning to live at least a million times more wisely than he now lives, is likely to have a much larger influence upon human conduct than either the airplane or the radio."

Positive proof that the earth is a billion years old is found in radium-bearing rocks, Millikan explained. Radium has a known duration of life, in the course of which it gives off emanations, some of which evolve into lead. Lead so derived has a different atomic weight from "natural" lead. Uraninite, a radioactive mineral found in the Black Hills of South Dakota, contains this radium-derived lead, and exact measurement of its quantity and atomic weight, checked by geologists, physicists, and chemists of the highest standing, has been accepted by scientists as proof of the earth's age.

THIS atomic disintegration of radium has set up much speculation among scientists as to the possibility of extending the same process to other elements, and many amazing calculations have been made as to the amount of energy which could be obtained once humanity discovered how to pry electrons loose from their atoms, a process which would amount to annihilation.

According to J. H. Jeans, an English astronomer, that is what is going on throughout the universe; the sun and all the stars we can see are constantly disintegrating to produce radiation, but this annihilation takes place only in matter of a heavier atomic weight than uranium, which is the heaviest known on earth. The youngest stars, Dr. Jeans believes, are composed of elements of which we have no knowledge.

IF WE could apply this principle of annihilation to our familiar elements we could accomplish marvelous results. "A ton of coal provides energy enough to drive an express locomotive for an hour," says Dr. Jeans, "but the annihilation of a ton of coal would provide enough energy for all the heating, lighting, power, and transport in Great Britain for a century!"

Millikan agreed with Jeans, but went much further.

"The process of radioactive disintegration can take place only in the case of a very few (Continued on page 140)

SCOTTY ALLAN—
Master of the Frozen Trails

Tells His Own Story to FITZHUGH GREEN

Scotty Allan, driver of Alaskan sledge dogs, with two of his huskies. "In a bad jam," he says, "I'd rather have dogs than men."

"HOW does it feel to face death?"

I don't know why that question always makes me want to laugh. People ask it often enough. Probably it's because the person who asks it doesn't realize that a fellow hasn't time to think *how* he feels when he's hanging on by an eyelash and expects every moment to be chucked into eternity.

What I do know is that in a bad jam I really believe I'd rather have dogs around me than men. In a crisis a good dog can think twice as fast as the average man; he is brave, and his judgment never blows up. For example:

I heard the voice of death on a biting cold afternoon in April, 1910.

"*Whoo-ish-hhh!*" was what it sounded like—a sort of terrible whisper.

Any man who has stood on the brink of a thousand-foot precipice with a snow avalanche breaking away right under his feet to plunge him to the rocks far below will know how desperate I felt at that moment. There wasn't time to think. There wasn't anything to grab for. It was just one of those million-to-one bets that my life was coming to a swift and violent end on the side of a high Alaskan mountain and that my crushed body would be buried so deep in the flying snow that people wouldn't find it until late the following summer—if they ever found it at all.

I have my team of ten husky dogs to thank for the fact that I can still tell the yarn of what happened on that day.

It was right in the middle of the 1910 Alaska Sweepstakes. This famous race was held at Nome every year. The course was 410 miles long, Nome to Candle and back, over sea ice and mountain, through bitter cold and heavy blizzards. It was a man's job to drive it, if I do say so myself.

I had never had a better team. We hit a great clip on the out-trail, making Candle, 205 miles north, in nineteen hours and forty-six minutes. That includes time out for resting and feeding; which shows what a killing pace we traveled. We led the bunch.

On the way back I was still leading. It looked as if I had the race cinched. As there was over $130,000 up I felt pretty good.

Then I got it in the neck. I was taking a short cut over the hog-back of a wind-swept mountain. I suppose the bitterly cold wind that was blowing made me want to get off that exposed place. But I had some trouble taking the dogs near the edge so I could hurry down.

They had better sense than I did.

We were racing along the crest of a huge drift. I doubt if it ever melted even in the summer. A few feet to one side was the vertical face of the mountain.

Suddenly I heard that awful "*Whoo-ish-hhh*" of packed snow breaking loose. My heart stood still; I knew what it meant. I didn't feel or think or even worry. I was too sure it was all up with me.

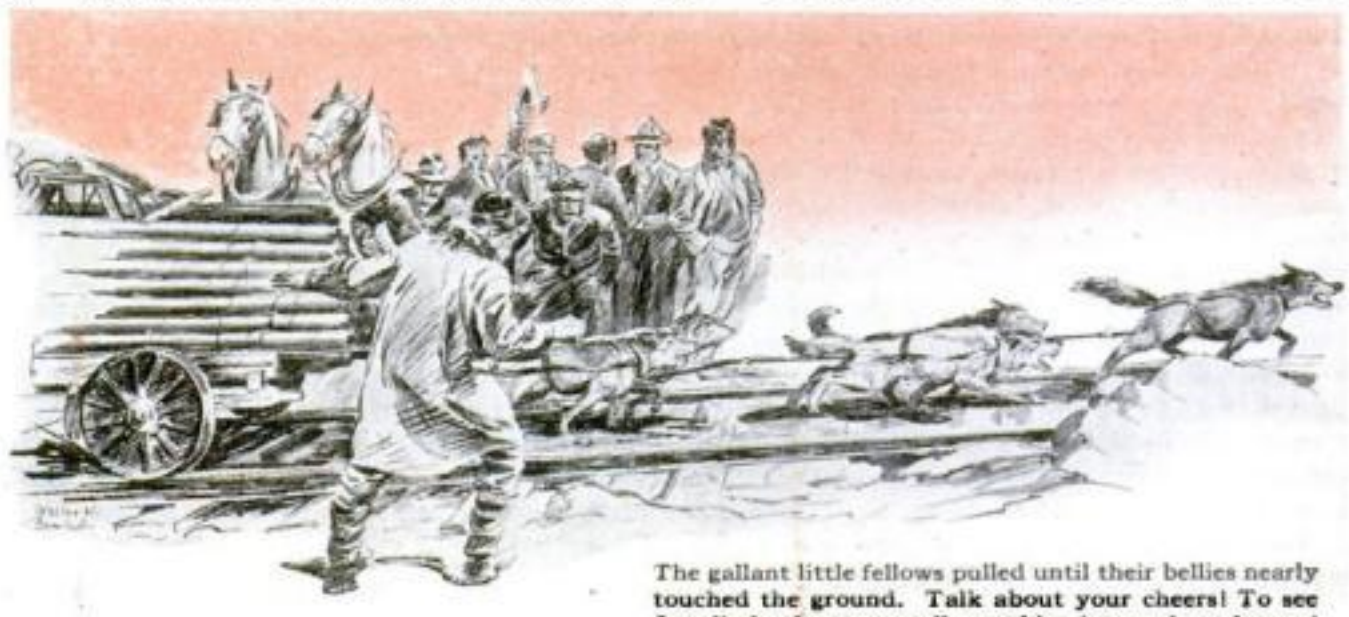
Not so the dogs. They were old campaigners and knew as well as I that we were probably doomed. But they didn't give up, not for a single instant.

Before I could open my mouth to yell they swerved. In a flash they had yanked the sledge and me twenty feet nearer safety. Then, as we began our giddy fall, they dug in with their toes and even their snouts.

That incredibly quick jump by the dogs saved my life. For had I been out on the edge we should have fallen twice as far; and there wouldn't have been enough snow to cushion our bodies when we landed on the rocks far below.

As it was we dropped only about two

Jack leaped for my throat. I met him in mid-air, clutching with bare hands at the soft woolly skin about his open jaws.



The gallant little fellows pulled until their bellies nearly touched the ground. Talk about your cheers! To see five little dogs out-pull two big, heavy dray horses!

hundred feet straight down. From a ledge we rolled to the bottom. I was stunned; but I knew I wasn't killed. When I got my wits together I scraped the snow out of my eyes and mouth and untangled myself from the wreckage. Five dogs were up sniffing at me. Three were badly hurt, and two were ready for the undertaker.

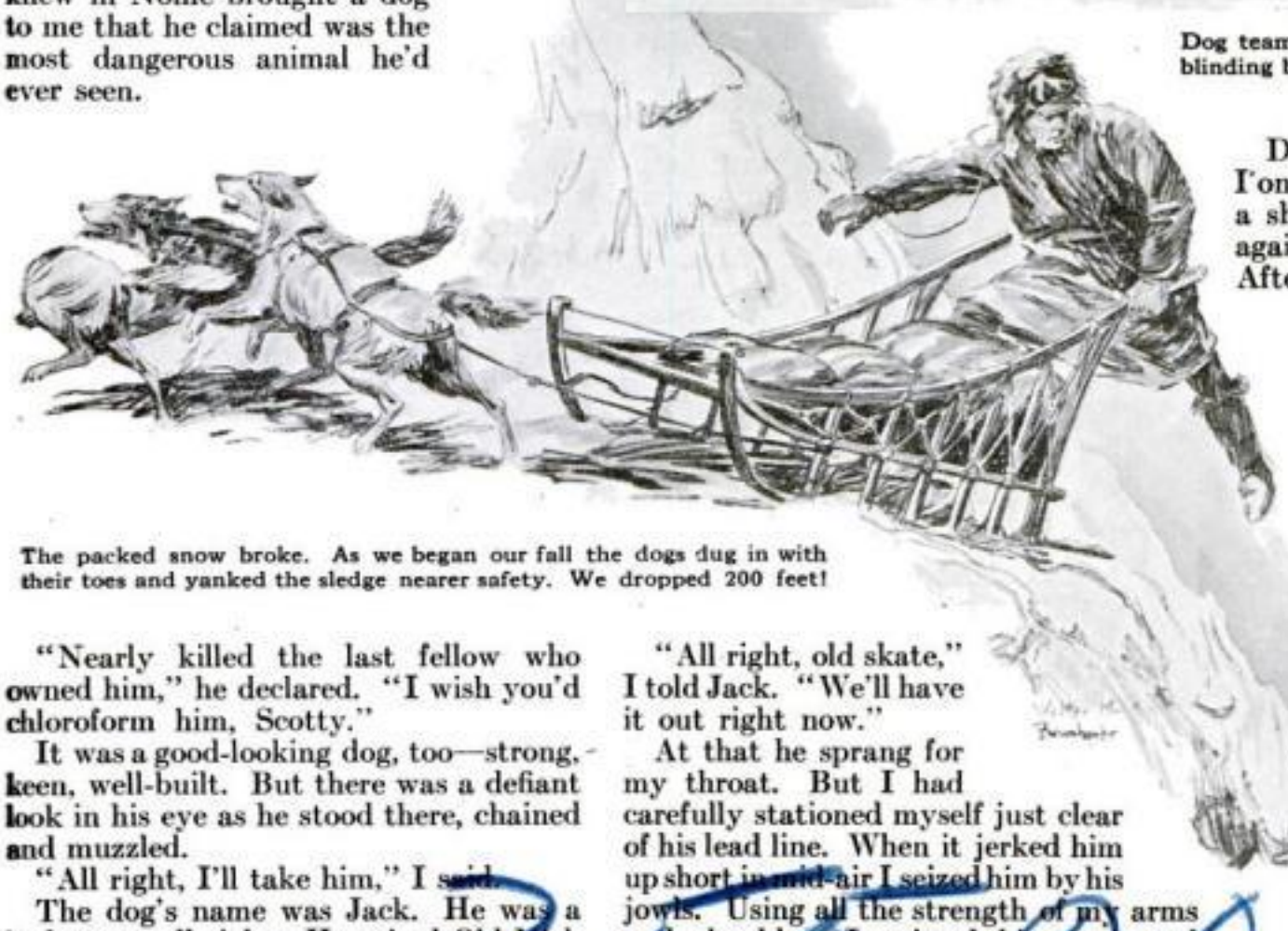
But due to the quick thinking of my dogs I lived. Moreover, with my wreck of a team, I finished the race and came in second to boot!

Don't think, however, that just because you own a dog he's going to stand by you the way that grand team stood by me. The dog must first recognize you as his master. He shouldn't fear you; he must respect you, and be gladly ready to obey you the instant you speak.

You can't beat such faithfulness into a dog.

A few years ago a man I knew in Nome brought a dog to me that he claimed was the most dangerous animal he'd ever seen.

Dog teams at Nome, Alaska. Through bitter cold and blinding blizzards, these sturdy little animals carry on.



The packed snow broke. As we began our fall the dogs dug in with their toes and yanked the sledge nearer safety. We dropped 200 feet!

"Nearly killed the last fellow who owned him," he declared. "I wish you'd chloroform him, Scotty."

It was a good-looking dog, too—strong, keen, well-built. But there was a defiant look in his eye as he stood there, chained and muzzled.

"All right, I'll take him," I said.

The dog's name was Jack. He was a bad actor, all right. He raised Old Nick in my kennel and wanted to kill every other dog in the gang. He watched me out of the corner of his eye when I was around, just waiting his chance to show me what he thought of all men. I guess he'd been pretty badly used ever since he was a pup.

After four days I harnessed him. My wife was scared he'd get me. But I know dogs well enough to see when trouble was coming. On purpose I didn't have my whip in my hand. I think that puzzled Jack. He'd never before seen a man try to handle him without beating him up first. He was going to wait and find out what my game was before he started anything.

Soon as he was hooked on the tow line he began to make a racket. I went up and cracked him lightly on his nose with my glove.

"Shut up, you idiot," I told him.

He came for me like a wolf. His teeth snapped a half inch short of my hand, which I jerked away just in time. The rest of the team were all for finishing him off then and there. But I quieted him with a word.

"All right, old skate," I told Jack. "We'll have it out right now."

At that he sprang for my throat. But I had carefully stationed myself just clear of his lead line. When it jerked him up short in mid-air I seized him by his jowls. Using all the strength of my arms and shoulders I twisted him over and landed him on his back in the soft snow. This threw him into a mad fury.

It had to be a fair fight or I wouldn't make my point. So I sprang forward and unhooked him before he could come for me again.

Again I met him in mid-air, clutching with bare hands at the soft woolly skin on either side of his jaws before he could get his teeth in my throat. It was dangerous work, but I had done it before and knew where to grab.

NO ONE knows more about dogs than Scotty Allan. He is called the greatest master and racer of sledge dogs in Alaska. They have been his companions in raging blizzards and when death was near. His feats of daring in the All-Alaska Sweepstakes, the dog classic of the north, form an amazing drama.

Down went Jack into the snow again, I on top of him with all my weight. After a short struggle he began to relax. Up again I got; and again he came for me. After I had thrown him to the ground three times he quit. I hadn't hurt him one mite; but I had shown him who was boss.

"Come here, boy," I commanded gently.

His belly scraping the snow, he crawled to where I stood. I patted his head.

"Now you and I are going to be friends, Jack."

Slowly he stood to his feet and wagged his tail. Then suddenly he gave a look over his shoulder at the rest of the team as if to say:

"Well, this isn't a bad guy after all!"

Jack became one of the greatest sledge dogs of the North, and my most loyal friend until he died of old age.

You can't be around dogs long without seeing a lot of dog fights. There are a hundred reasons why one dog attacks another, and not the least of these is the pure joy of battle.

Strange to say, the greatest dog fight I ever saw wasn't in Alaska at all, but in France. But they were Alaskan dogs doing the fighting.

I was a block away when I heard the uproar. Two dogs good and mad, snarling and screaming at one another, can make a pretty good row. You have no doubt heard as many as three or four going after one another. If so, you may be able to imagine what this fiendish noise I heard was like, when I tell you it came from the throats of *more than four hundred dogs!*

Think of it—over four hundred dogs all locked up in the same compound and all screeching at once while they tried to tear each other to pieces! *(Continued on page 178)*

Science Takes Stock of Its Conquests—

Dr. Eugene Lyman Fisk, Life Extension Institute: "We can live longer. Old age is a disease."

Dr. W. H. Hobbs, University of Michigan: "Humanity has survived three ice ages."

Prof. Harlow Shapley, Harvard: "Fifteen hundred million million miles."

Prof. Henry Fairfield Osborn. Elected president of the Association.

Willis R. Gregg, U. S. Weather Bureau: "Weather reports for flyers along airways."

Dr. John J. Abel, Johns Hopkins: "Synthetic insulin, diabetes cure, has been made."

Dr. Franz Boas, Columbia: "Man originated somewhere between Italy and Java."

Prof. Edward G. Boring (left), Harvard: "Fights are good for science."

A NEW concept of the extent and dimensions of the universe, the announcement of the discovery of a method of isolating chemical substances in the blood which has heretofore defied research, reiteration with new proofs of the doctrine of human evolution, a more detailed estimate of the age and the composition of the earth, and a heated discussion of the scientific concept of the Deity, were features of the recent eighty-fifth annual meeting of the American Association for the Advancement of Science, in New York.

Nearly five thousand scientists, most of them university professors, attended the meeting. The results of research in a hundred different lines of scientific endeavor for the year were reported and debated. The most striking developments at the meeting are summarized here.

ASTRONOMY

THE galaxy of which the earth is a part is about fifteen hundred million million miles across, Professor Harlow Shapley, director of the Harvard College Observatory, announced. A galaxy is a complete system of stars and planets. Ours contains about ten billion stars. But there are thousands of independent galaxies outside of our own, some appearing as spiral nebulae, some as Magellanic clouds. Our own universe is from five to twenty times as large as any other visible through the most powerful telescope so far. The most distant galaxies are more than a hundred million light-years away, that is, it takes a hundred million years for their light, traveling 186,000 miles a second, to reach us. Set down in figures this is about 586,569,600,000,000,000,000 miles!

When the new 200-inch telescope for the California Institute of Technology is completed many new universes four times as far away probably will be discovered, said Dr. Walter S. Adams, Director of the Mount Wilson Observatory. Stars of the twenty-fifth magnitude will be visible. The light which comes to earth from such a star is about what would come from a candle 41,000 miles away. The new telescope also will enable astronomers to make a weather map of Mars.

The climate of the moon is even worse than that of the earth, Edison Pettit and Seth B. Nicholson, of the Mount Wilson Observatory, reported. At noon the temperature rises to 265 degrees, but as the sun sinks it drops at the rate of more than seventy degrees in twenty minutes, until it gets down to 196 below zero, cold enough to freeze alcohol.

HEALTH

ONCE people get rid of the superstition that there is a normal limit of seventy years to their lives they will live longer, said Dr. Eugene Lyman Fisk, director of The Life Extension Institute. There is no such thing as physiological old age, he added. It is a disease and is always caused by disease. Time has nothing to do with the hardening of the arteries. He predicted that endocrinology, the science of the action of the ductless glands, will help prolong the average of human life.

For isolating hormones, the active principle secreted by the ductless glands, Dr. Oliver Kamm, chief of chemical research of Parke, Davis and Co. of Detroit, received the association's annual prize of $1,000. One of the hormones secreted by the pituitary gland at the base of the brain enables the body tissues to retain water, he said. Fat persons have too much reaction to this hormone; they should drink less than thin folk.

Professor John J. Abel and Dr. H. Jensen of the Johns Hopkins School of Medicine reported they had been able to make crystalline insulin, a remedy for diabetes, synthetically in the laboratory. Insulin is the hormone secreted by the pancreatic gland.

Knowledge of the action of the ductless glands may save society $10,000,000,000 a year by eventually eliminating the nine million defectives who are abnormal because their glands do not function properly, Prof. Rudolph M. Binder of New York University told the Association. Application by sociology of knowledge of the ductless glands, he said, might enable the world to understand geniuses and recognize military heroes "for what they are, physically and mentally unbalanced individuals."

CHEMISTRY

CHEMISTRY can make anything out of anything, apparently. Dr. Charles H. Herty, adviser to the Chemical Foundation, Inc., estimated that the production of valuable materials out of former wastes has progressed to the point where the utilization of forest resources will increase by 200 percent, through the manufacture of synthetic products from wood wastes in the lumber business. Factories have been established for the manufacture of paper and other products from waste cornstalks. Pyroxylin lacquers, now universally used for finishing

THE American Association for the Advancement of Science, probably the world's greatest body of leaders in research, recently held its annual meeting in New York City. Just what did its many reports and discussions mean to you and me? To help you grasp their real importance, the editors of POPULAR SCIENCE MONTHLY present here in brief, understandable terms the first complete bird's-eye view of outstanding achievements revealed at the meeting. Here's the world of science at a glance.

motor cars, resulted from the need for using up the immense stocks of smokeless powder left from the war.

Organic chemistry is teaching the farmer to make the lower forms of life, bacteria and molds, work for him, said Dr. Edwin E. Slosson, Director of *Science Service*. They pay better than ordinary livestock. By the aid of these microorganisms sawdust or waste molasses, combined with ammonia made from the air, all sorts of fats, protein foodstuffs and flavors have been made. Chemical research has shown many ways to increase the growth and value of food plants and animals.

PHYSICS

"BALLOON juice" is being manufactured in interstellar space, Dr. A. A. Noyes of the California Institute of Technology, retiring president of the A.A.A.S., announced. An atom of helium, the gaseous element first discovered in the sun, he explained, is composed of four protons, or nuclei of hydrogen, and two electrons, which are something else again. The effect of such a combination would be an enormous release of energy, Dr. Noyes said, and the penetrating cosmic rays recently measured by Millikan and Compton give evidence of originating in that combination somewhere in outer space.

Atoms of many substances are constantly disintegrating, Dr. Noyes said, but it takes some a long time to do it. Certain atoms have a half-life of billions of years; others disintegrate completely in a fraction of a second.

ANTHROPOLOGY

"I MAKE the formal indictment against godlike, erect-walking man that every bone in his skeleton testifies to his descent from the mud-crawling reptiles of the coal swamps," Professor William K. Gregory of the American Museum of Natural History, thus threw down the gauntlet of the evolutionists. Man and the higher apes came from the same stock not many million years ago, he asserted, but it has taken perhaps 300 million years to develop a mobile face, and, through tree-climbing, serviceable hands and feet. Man's ability to walk erect, Dr. Gregory believes, made him "a peculiarly inquisitive and acquisitive animal, using his front feet for the purpose of helping himself liberally to everything in sight."

Dr. Franz Boas, of Columbia University, estimated that somewhere between 500,000 and 1,000,000 years marked man's existence so far, but would not fix the place of his origin closer than "somewhere between Italy and Java." Dr. Ales Hrdlicka of the Smithsonian Institution, however, declared that much more excavation and research was needed before we could say definitely where and when man originated.

It was a good thing for man that the ice age forced him to "hole up" in winter, declared Professor Henry Fairfield Osborn, new President of the Association. For it compelled him to invent clothing, implements, tools, to discover fire, and enabled him to develop art, languages and mythology. Dr. W. H. Hobbs, of the University of Wisconsin, asserted that humanity survived three "ice ages," in which a large part of the earth was covered by glaciers.

Dr. Charles P. Berkey, of Columbia University, a member of the Andrews expedition to the Gobi desert, reported finding tools made of jasper corresponding to flint tools made by Europeans from 40,000 to 200,000 years ago. Twenty thousand years ago descendants of those ancient tool makers are believed to have crossed from Asia to America and developed a civilization of their own.

PSYCHOLOGY

ROWS between scientists are a good thing for the progress of science, Prof. Edward G. Boring, director of the Harvard Psychological Laboratory, told the Association. Scientific progress begins by someone calling someone else a liar, and so putting it up to the one whose theory is challenged to make good or admit he is wrong.

Dr. Knight Dunlap, of Johns Hopkins University, who has been called a liar by fellow psychologists for saying that the way to break a bad habit is to repeat it consciously and frequently, deplored present methods in psychological research, resulting, he said, in isolated and fragmentary knowledge which leaves fundamental problems unsolved. He would have the Federal Government establish a national psychological laboratory, free from prejudices and fads, where long experiments could be carried to completion.

"Timing" is more important than "form" in every kind of athletics, said Dr. Coleman R. Griffith, director of research in athletics and associate professor of psychology in the University of Illinois. Some boxers, golfers, tennis players have (*Continued on page 174*)

Dr. A. A. Noyes, California Institute of Technology. Retiring President of Association.

Prof. Bailey Willis, Stanford: "Continents are founded on the earth's blisters."

Prof. W. K. Gregory, Amer. Museum: "Man came from a mud-crawling reptile."

Dr. Ales Hrdlicka, Smithsonian Institution: "We don't know where man came from."

Dr. Charles P. Berkey, Columbia University: "Jasper tools from the Gobi desert."

Dr. Harry Elmer Barnes, Smith College: "We need a new concept of God."

Prof. Alfred C. Lane, Tufts College: "The earth is about a billion years old."

Dr. Oliver Kamm (right), industrial chemist. Winner of $1,000 prize, for best paper.

Far above city roof tops, the sky-writing plane streaks across the blue sky, tracing in mile-long letters of smoke a message read by hundreds of thousands of people below. The smoke forms a billowing rope forty feet thick.

Captain LeBoutillier, veteran sky-writer, in the tight-fitting cockpit of his speedy plane.

Capt. O. C. LeBoutillier—

A Famous Sky-Writer Tells of His Job

POOR old McMullin—he certainly got the ears kidded off him that time. But he had it coming to him. Imagine an experienced sky-writer going up and writing backward!

I am a sky-writer. You know what that is, of course. One of those fellows who give city folks cramped necks while they watch him twist and loop. Every time he loops he traces another letter with white smoke that spurts from the tail of his plane.

Such was the show New York saw when it discovered that the city was 300 years old and decided the way to celebrate it was to have a jubilee. So the streets were draped in bunting, flags fluttered from the towers, and up went McMullin, an Englishman, to sky-write about it.

About 10,000 feet up he leveled off and started writing. Crowds in the streets stopped to watch him, then gasped. He apparently had gone crazy, because he was tracing the cryptic message:

He never knew it! At least, he didn't when his plane came down and stopped at our hangar on Curtiss Field, N. Y.

"How'd it go?" I asked him, not knowing what had happened.

"All right. Air's a bit bumpy, but a nice blue sky. Guess I'll call up the boss."

The "boss" is Allan J. Cameron, president of the Skywriting Corporation of America, which holds the sky-writing patents for the United States.

"Hello," asked McMullin, "how did you like the show?"

What Cameron said I don't know, but I could hear the telephone receiver making the curious rattling noises it does when someone at the other end is talking in an exceedingly animated tone. McMullin came back with the reddest face I ever saw on a man Then the story came out—and we haven't let him forget it yet.

It takes queer incidents like that—and every now and then some odd accident does happen—to make clear the inside stuff of sky-writing. Not everyone realizes for instance, that if a sky-writer splashed his message on the sky right-side to, from his viewpoint (as McMullin did, for instance), the man on the street would not be able to read it—unless he stood on his head. So the pilot writes backward, with the aid of a little chart attached to his dashboard; and, when you read the message from below, it looks all right. Incidentally, we have a patent on writing backward!

YOUR professional sky-writer is a trained aerial acrobat. He can scoot across the sky in a cockleshell fighting plane, at a hundred miles an hour or more, writing backward as he goes. This, of course, while he looks at his chart. If he

ONE of aviation's most picturesque figures, Capt. O. C. LeBoutillier, R. A. F., tells here of his experiences in the spectacular game of sky-writing. His is a story of adventure and dare-deviltry, seasoned with humor.

Known as "Boots," Le Boutillier is an American who served in the British Royal Air Force. As a war pilot he won the coveted Distinguished Flying Cross. He was Miss Mabel Boll's pilot on her attempted trans-Atlantic flight from Newfoundland and recently was selected by Mrs. Anne U. Stillman as co-pilot of her plane, the *North Star*, for a nonstop flight from Pernambuco, Brazil, to New York. He has been a sky-writer since 1926.

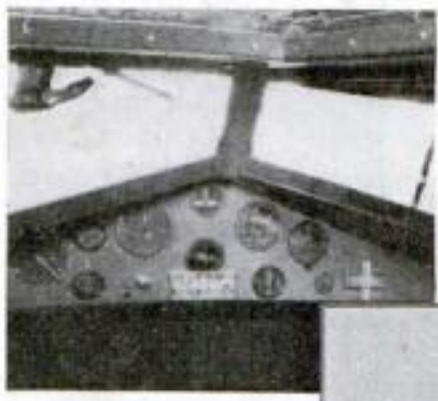
can watch the dials on his dashboard and the gages on his chemical tanks as well, he is a very good sky-writer.

A sky-writing plane carriers, or should carry, two hundred pounds of the chemicals that produce smoke when it takes the air. That is just about enough for a short snappy sky message. If "brevity is the soul of wit," we sky-writers are among the drollest fellows on earth. A long message simply can't be sky-written, and on that fact hangs a little story.

WHEN the Prince of Wales visited New York City several years ago, Cameron suggested it would be a nice gesture to sky-write a welcome. "Hello, Wales" was what he proposed. Everyone thought it a splendid idea except one of our pilots—Capt. Cyril Turner, the first sky-writer in the world. Turner, an Englishman himself, was doubtful about the propriety of addressing the heir to the British throne in such a typically American way. He called up the British Consul and asked his advice.

"Ahem," replied the Consul. "I really don't know that that would do. In fact, I don't think that it would do at all. Let me see. I have an idea. Suppose you write this — 'Welcome his Royal Highness the Prince.'"

Any pilot attempting to write a phrase like that probably would run out of fuel, let alone smoke. Estimating conservatively, it would stretch out twenty-five miles in the sky. Regretfully Captain Turner explained he couldn't fill quite such a large order and the project was abandoned.

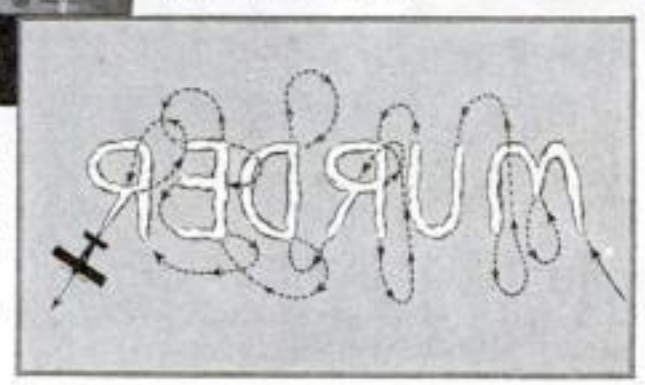


Writing backward, the pilot is guided by a chart, seen just below center of instrument board above.

IF A motorist feels foolish when he runs out of gasoline, it isn't hard to imagine how a sky-writer feels when his smoke gives out while thousands are watching him. One of life's darkest moments for one sky-writer—Capt. C. B. D. Collyer, who met his death not long ago in a cross-country race against time—was during an advertising campaign over Brooklyn, N. Y. Spectators saw his plane weaving a message and then, in the middle of a letter, the smoke stopped. Collyer traced two or three more letters, not realizing his plight. Then the truth dawned on him and he hovered for a second or two, undecided. Watchers next saw the tiny plane turn tail and scud away as fast as it could go for Long Island and the landing field.

There's nothing a pilot can do when he runs out of smoke. He's simply "out of luck." An indescribable feeling of helplessness comes over him and he longs to speed as far as possible from the scene of the mishap.

Sky-writers do not carry erasers. If a word is misspelled the only thing to do is to cross out the offending letter. Once Collyer pulled a stunt like that over San Francisco, as I recall it. He had reached the fifth letter when the throngs looking on began to snicker and nudge elbows. Collyer was spelling "Lucky" with two "k's."



The dotted loops show the turns and twists made by a tiny plane in jockeying to sky-write the difficult word "murder" in smoke.

Undismayed, Collyer finished the word, went back and crossed out the extra "k" with a trail of smoke. Only a few of us knew he did it on purpose, so he was rewarded by some coveted publicity in the newspapers. I don't know of an incident where a sky-writer accidentally misspelled a word. It could happen, of course, but it's unlikely with a diagram in front of him.

Advertising a rodeo show with huge letters a mile above New York skyscrapers. Note how wind has carried and blurred first letters.

WHEN I made my sky-writing début I felt like an actor appearing for the first time—and probably that goes for every novice. Not that you do your first turn over a city. That would be too uncertain altogether. Many a good pilot falls flat as a sky-writer. So the first try-out is over the flying field. Up goes the novice with his smoke all ready and starts to write.

On the ground, observers draw a little diagram to show him his faults when he comes down. For instance, the first time his writing may slant "downhill" and a little practice will enable him to level it up. It's a curious thing, by the way, that a pilot's handwriting doesn't resemble his sky-writing in the least; he may pen a short, fat hand and sky-write in long, slim letters.

Even experienced sky-writers practice a message they are going to write above a city—or, perhaps, just a few letters of it; some of the difficult combinations. Long messages are not the only ones that can't be sky-written; sometimes the word is impossible to trace because the (Continued on page 138)

Just before he takes off, the sky-writer tests his "smoker" by short puffs. Note the long tube, connected to the motor's exhaust, which discharges the hot chemical smoke, sky-writers' "ink," just behind rudder.

Once Edison Was An Editor

But He Was Thrown Into the River for Being Too "Snappy"—Dramatic Episodes from His Crowded Life

By JACK O'DONNELL

"NOBLE, kindly servant of the United States and benefactor of mankind, may you long be spared to continue your work and to inspire those who will carry forward your torch!"

Thus spoke the President of the United States over the radio to Thomas Alva Edison one night a few months ago, when the great inventor received a medal voted by Congress for a lifetime of inventing, which brought us to "The Age of Electricity."

Almost three quarters of a century before, this same Thomas Alva Edison heard reference to a "torch" under far less auspicious circumstances. At that time the constable of the little town of Milan, Ohio, Edison's birthplace, held young Edison by the scruff of the neck while he lectured him on the danger of matches, while folks stood in the public square waiting for the officer to apply the lash.

Edison, then five or six years old, was being made "an example of." While playing in a barn he had started a fire which got beyond his control so quickly that he was lucky to escape with his life. The punishment was a whipping in the public square as a warning to other boys, and a lesson to "Al," as he was called in Milan.

NO DOUBT the constable had a good time whipping young Edison, as he probably considered the lad "wuthless." A teacher of the Milan school a short time before had spoken of the boy as being "addled," while others in the town regarded him as mentally unbalanced and likely to end on the gallows.

Fire has played an important part in the life of the world's greatest inventor. It was a fire—the second in which he was vitally involved—that cost Edison his hearing. He was working as a newsboy on a train of the Grand Trunk Railroad between Port Huron and Detroit, earning money to buy materials for experiments in chemistry, in which he had become interested when he was eleven years old. Edison got permission to use part of the baggage car as storeroom for his papers and candies. Soon, however, he transferred his chemical "laboratory" from his mother's cellar to the car, where he found time to pursue his studies. Here also he set up a secondhand printing press and began publishing a newspaper which he called the *Weekly Herald*, becoming the first publisher of a newspaper printed on a train.

One day a stick of phosphorus rolled from a shelf and fell to the floor. In a few minutes the car was on fire. The conductor rushed in with a pail of water and quenched the fire. The "skipper," a hot-headed Scotchman, boxed the lad's ears so severely that the drums were injured. This injury ultimately resulted in Edison's almost complete loss of hearing.

Edison lost his job as newsboy. Discouraged, he made his way back to Port Huron, Mich., where his parents then lived, and again set up his laboratory and printing office in the cellar of the family home. Edison liked the editing business and might have grown up to be a Greeley or a Dana had it not been for an irate reader. It seems that Edison was persuaded by a chum to change the name of his *Weekly Herald* to *The Paul Pry*, and to make it a snappy journal of personalities rather than a reliable news agency.

But Edison was ahead of his times. Michiganders proved a sensitive, resentful lot. One day *The Paul Pry* carried a story about a hypersensitive young man of the city which set the gossips' tongues wagging. That night the young editor was rudely tossed into the chill waters of the St. Clair River. The hypersensitive young man did the tossing.

This experience dampened Edison's enthusiasm for a journalistic career. Soon he gave up the paper and turned to chemistry and telegraphy exclusively.

WHILE a newsboy an incident had occurred which turned young Edison's thoughts definitely toward electricity. One morning in the summer of 1862 while cars of the train on which he worked were being switched about at Mount Clemens, the little son of J. U. Mackenzie, the station agent, was playing in the gravel on the main track. Suddenly Edison saw one of the cars which had been "kicked" out of a siding coming down the main line with nobody on it. Directly in its path was young Mackenzie. Edison dropped his newspapers and dashed to the lad, picked him up, and hurled himself and his charge off the rails. But Edison failed to get entirely clear, and a wheel of the car struck his heel. Both lads fell into the gravel alongside the track, cutting their faces and hands.

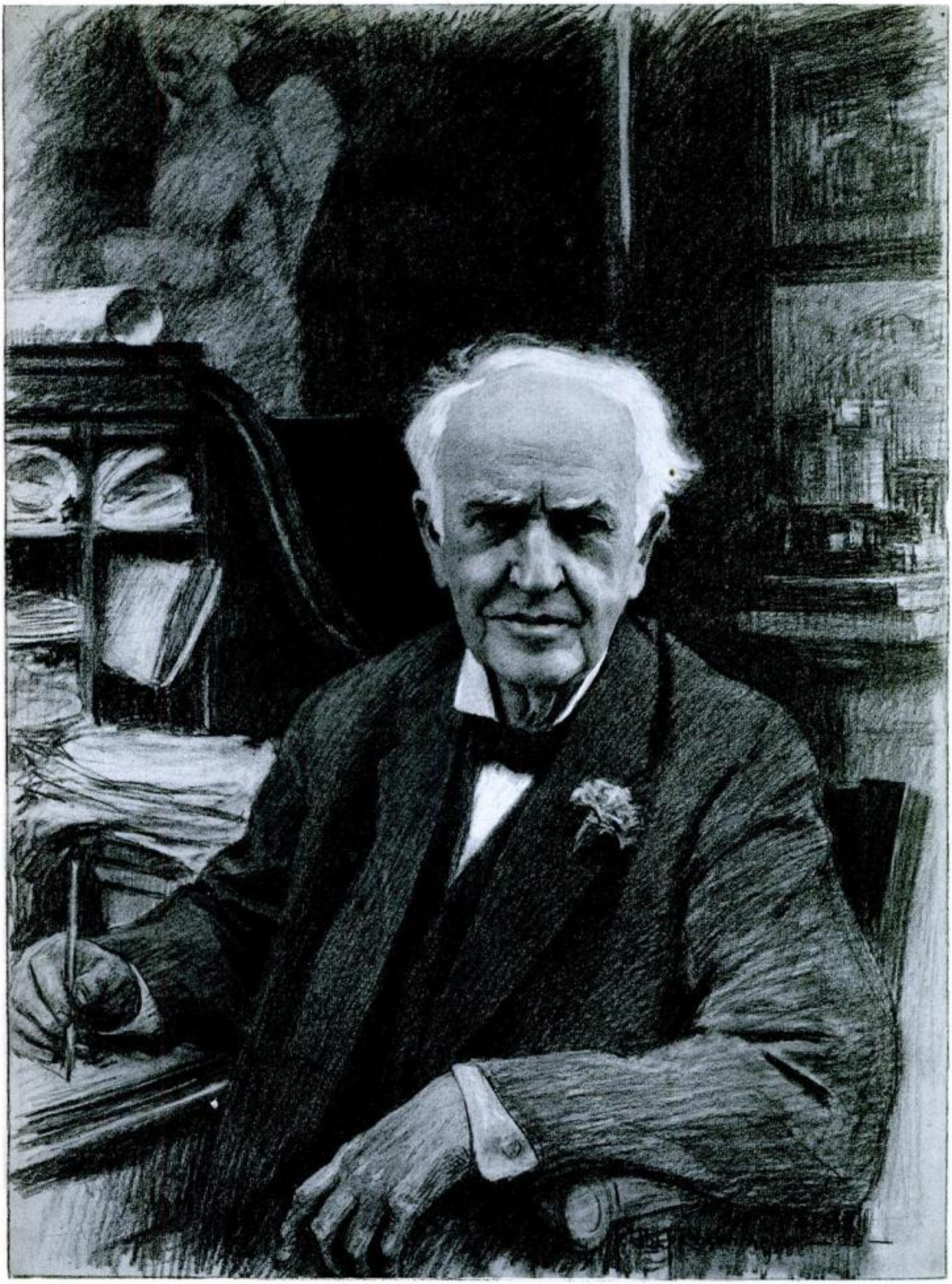
Mackenzie, senior, admired the grit of the young newsboy. He agreed to teach Edison telegraphy as a reward for his heroism. The newsboy arranged to spend considerable time with Mackenzie, and after his discharge devoted from twelve to eighteen hours a day at the key. It wasn't long until he was so proficient that he was given the regular operator's job at Port Huron.

It was while working on the next job—the telegrapher's position at Stratford Junction, Canada—that Edison's inventiveness first asserted itself. At that time a rule on the Grand Trunk railroad required all telegraphers to send the signal "six" to the train dispatcher's office every hour during the night, the object being to assure the dispatcher that all operators were awake and on the job. This hourly (Continued on page 167)

Edison in his late twenties, when he was launching his first inventions.

PERHAPS more than any other scientist, Edison has been placed on a pedestal. And rightly so. He has done much to make our lives easier and happier. For more than half a century POPULAR SCIENCE MONTHLY has reported and interpreted his accomplishments to the American people.

And so we are pleased to publish this delightful story of the man whose name is a symbol of our age. It reveals him in a new and human light, yet explains the undying flame that leaped barriers and climbed to the heights.—THE EDITOR.



Drawn especially for Popular Science Monthly *by B. J. Rosenmeyer*

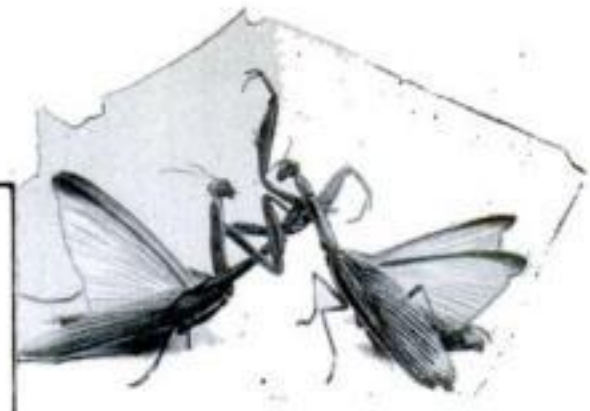
Thomas A. Edison, Genius of a Golden Age

By his hundreds of useful inventions, including the incandescent lamp, he has led the world to a new era of electric marvels. This remarkable portrait shows him as he is today, still at work at his desk on the quest of new inventions, still preserving the unbounded enthusiasm and vision of youth which have won for him the right to be called "benefactor of mankind."

Meet Some Queer Ones

STRANGE faces from many corners of the animal kingdom are brought to you here by our photographers, together with odd antics and thrilling battles among the beasts, birds, and insects—A surprising snake that robs hen-roosts—a lizard that can outclimb a human steeplejack

No dentist bills for the queer porcupine anteater of Australia. It has no teeth. But its back is armed with quills. And when frightened, it rolls up into a spiny ball.



In a clinch. When two long-armed praying mantes step into the ring, it's a long and thrilling fight to the finish.

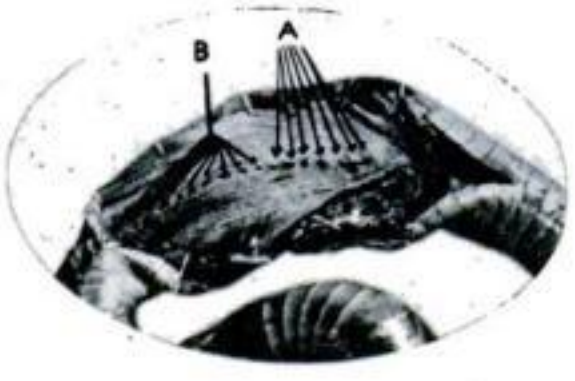
The feathers fly. Two well-fed turkey cocks, meeting in battle, stage as much grandstand play as a pair of clumsy heavyweights. Lots of fuss but small damage.

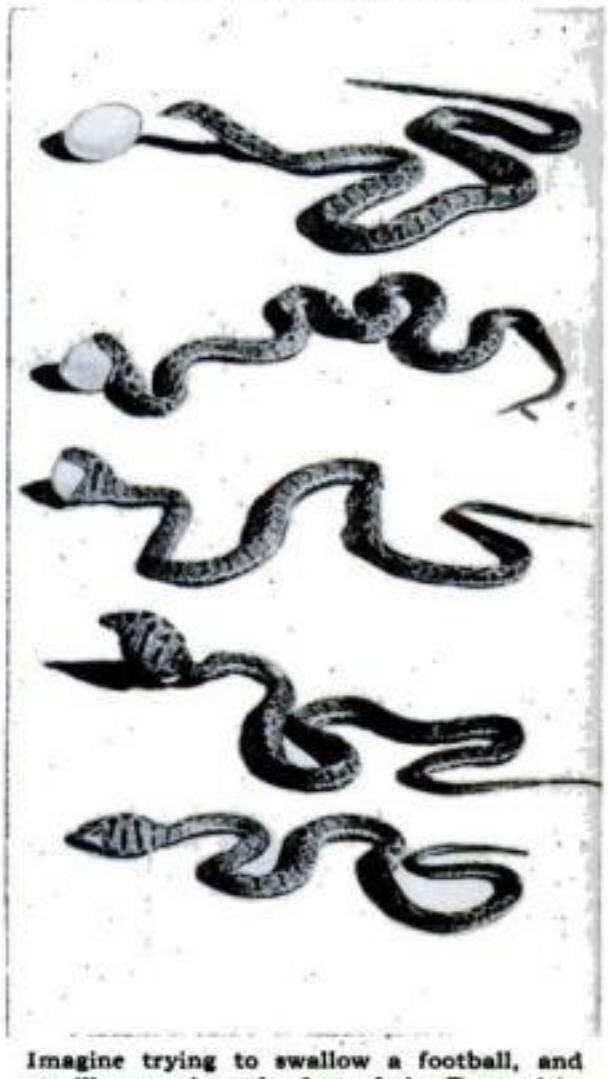
You might look like this, too, if you had a great South American condor strutting about on your shoulders. The bird, named Peter, is one of the most vicious residents of the London zoo. Yet Miss Anderson Parsons has so won his confidence that when she whistles a lively tune the huge bird starts to dance a jig.

Human steeplejacks may envy gecko the lizard which, with suction disks on its toes, climbs up walls.

With a warty complexion and teeth protruding beyond all reasonable limits, the wart hog of Africa is called the ugliest animal in the world.

In the crocodile family, even the newborn babies are cranky. This cute little fellow from Java, having his first good look at the world, is snapping his jaws at a finger which is being poked in his direction.





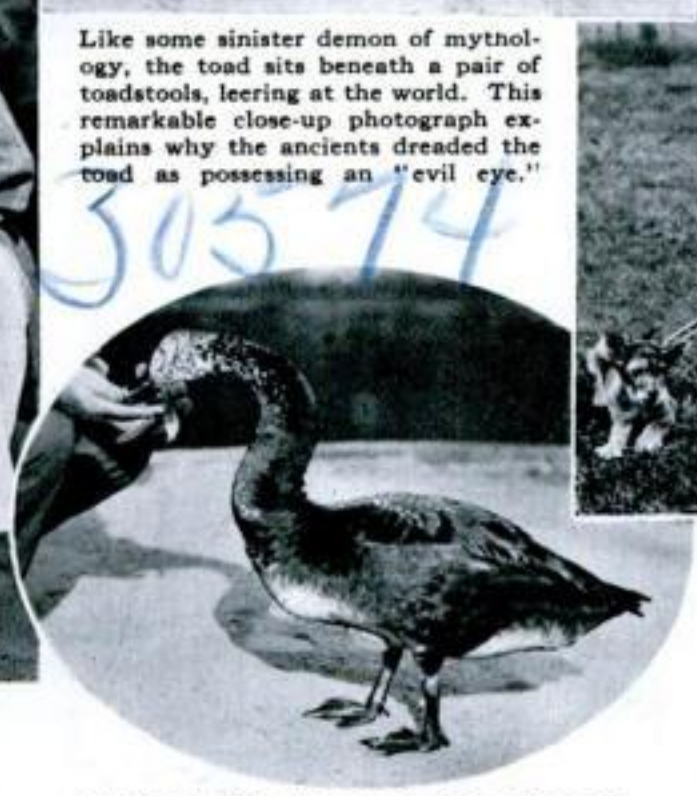
Imagine trying to swallow a football, and you'll appreciate the feat of the Dasypeltis, African snake, shown here swallowing a hen's egg much larger than its own head. Inside the snake's throat are spinelike teeth, at *A* and *B* in photo at left. These break the egg.

Cave dwellers among the birds. These so-called burrowing owls of North America keep house in the burrows of prairie dogs. Sometimes rattlesnakes live with them in the same abode.

Like some sinister demon of mythology, the toad sits beneath a pair of toadstools, leering at the world. This remarkable close-up photograph explains why the ancients dreaded the toad as possessing an "evil eye."

From the wilds of South Africa comes this fierce snake-eating bird. Even the most deadly reptiles are said to fear him, for, when hungry, he eats 'em alive, poison and all.

How would you like to have a leopard for a playmate? Just to prove that the spotted beast can be the most amiable of pets, W. H. Rogers, of New York City, sticks his hand in the big cat's mouth and greets you with a smile. But never before dinner.



What is it? It's a "swoose"—the only one in the world—a cross between a Canadian goose and an Australian swan. This queer bird lives in the Franklin Park Zoo, Boston, and its favorite dish is—believe it or not—bananas!

Taking the babies out for a stroll. This pair of three-months-old lion cubs from the jungles of Nigeria, Africa, are as playful as pups, and so harmless that even a small child leads them about on a leash at the London Zoo. But wait until the little fellows' voices change to a roar!

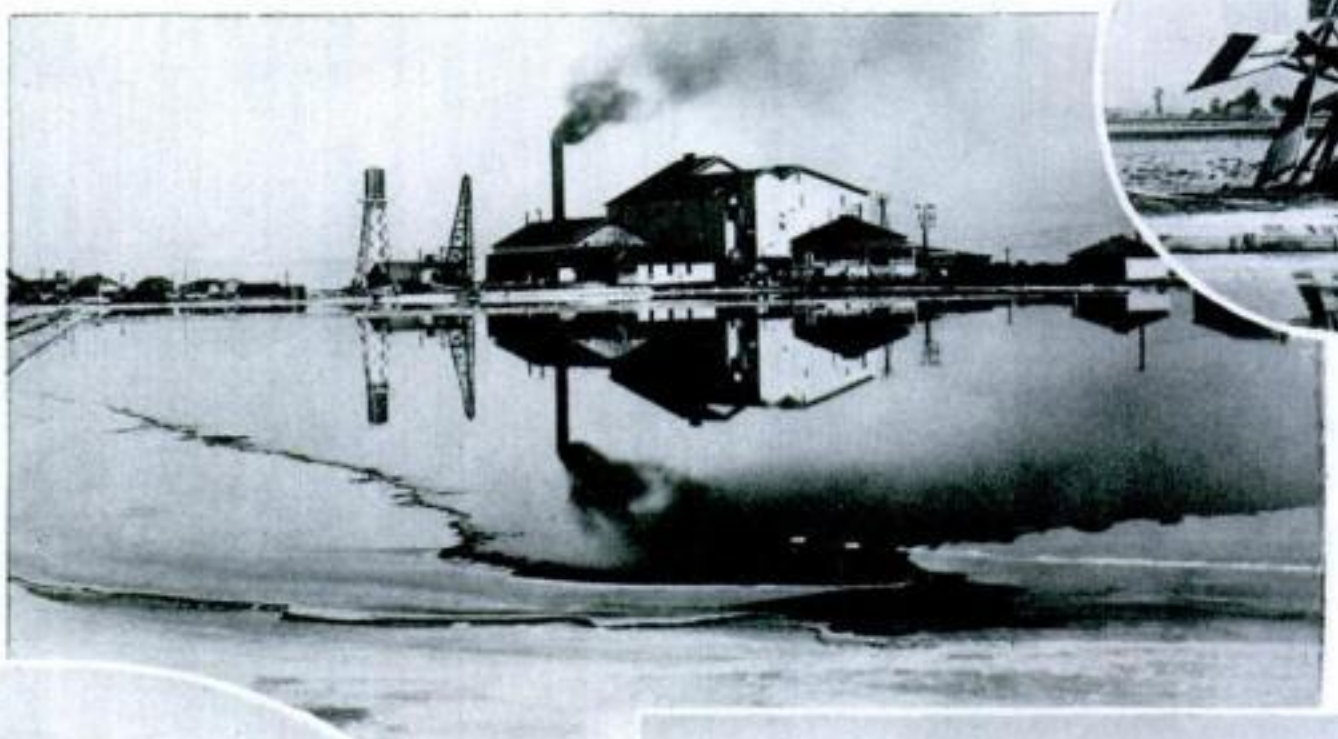
Those fluffy neckpieces women used to wear were made of the wonderful feathers of this queer bird, the African marabou, a large member of the stork family. Because of the great value of the long, soft feathers under the wings, the birds have been hunted almost to extinction. A few fine specimens, however, may still be seen in the zoos.

This curious salamander, the axolotl, belongs to one of the queerest tribes in the world. Ordinarily they are like tadpoles, swimming in the water. But sometimes they lose their gills and, like this one crawl out on land.

An American football game might seem tame to sport fans in India after witnessing an exciting head-on collision between a pair of tough-skulled rams. Here's a picture lesson for guards and tackles in the science of bucking the enemy's line.

Stealing the Sea's Salt

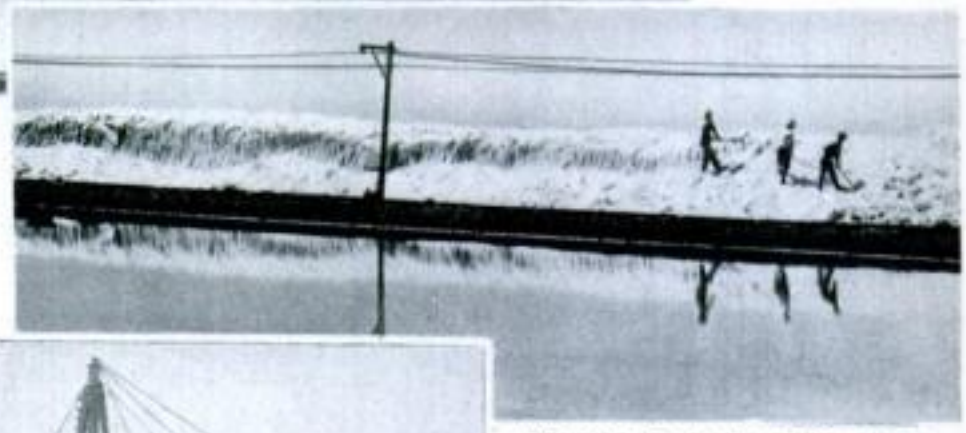
IF ALL the oceans were dried up, they would leave enough salt to form a tower a mile square and 4,500,000 miles high, or to build a continent fourteen and a half times the bulk of Europe above water! The pictures on this page show a remarkable salvaging plant on San Francisco Bay, California, which puts the sun to work to steal some of this vast treasure for everyday use by evaporating water from the Pacific Ocean.



Old windmill power plant once used in salvaging salt, now replaced by electric machines.

Left: Refinery of Leslie Salt Company on San Francisco Bay, and pond of sea water being evaporated.

One of the electrically driven wheels used in pumping water from the Pacific Ocean into evaporation ponds, where the sun draws off the water and the salt crystals are deposited from the brine. The ocean water at this point contains about four percent of salt, which is being reclaimed for use on our dinner tables.



Piled on the banks of the evaporation pond, the crystallized salt from the sea resembles great ridges of snowy ice. Each cubic foot of brine at the saturation point yields about nineteen pounds of salt.

Left: The yearly harvest. When the sun has done its work, the crude ocean salt, taken from the evaporation ponds, is washed and piled by these machines, then sent to the refinery to be freed of any impurities and made fit for human consumption.

These great compressed air tanks are employed in refining the ocean salt. The crude salt, as it is gathered from the evaporation ponds, is contaminated largely by sodium sulphate, a bitter soda. This is removed first by drying it into a fine powder, then blowing this powder away with compressed air, leaving the coarser salt. The latter is about 98 percent pure sodium chloride, or commercial salt.

After refining, the sea salt is ground and screened, then placed in bags and cartons to be shipped to all parts of the United States. Here is a corner of the plant's stock room.

Transported from the evaporation ponds in dump cars, the sea salt is piled in the open, then taken to the refinery as needed. This California plant covers about 600 acres, and is said to produce about 2,000 tons of salt in a year—all by putting the sun's heat to work.

Lives Saved by a Scarf!

Firemen Show How They Rescue Victims from a Burning Building with Help of a Neckerchief

Simple scarfs or neckerchiefs, like those worn by Boy and Girl Scouts, have become important life-saving equipment of American fire fighters. Boston firemen demonstrate here some of the ninety-odd ways the scarf may be used for rescue work.

To carry a fire victim to safety, the fireman ties the man's right knee and wrist together with scarf and slings the body over his shoulders, as above and at left. This leaves both hands free to grip ladder or carry ax and lantern.

From a room on an upper floor, a fireman overcome by smoke is rescued by a comrade. Crossing the victim's hands and binding them with a neckerchief, the rescuer shoves his head through the loop formed by the arms, and carries the limp form on his back.

Two saved from death at once—a double rescue made possible by a neckerchief. The fireman holds one victim on his back by tying the encircling arms with a flat knot. This gives rescuer use of both arms to grasp the second victim and carry him to safety.

A badly injured person may be saved much suffering and possibly further injury while being carried to an ambulance by tying and supporting injured limbs. The kerchief likewise is useful in an emergency as a splint, to bind broken bones.

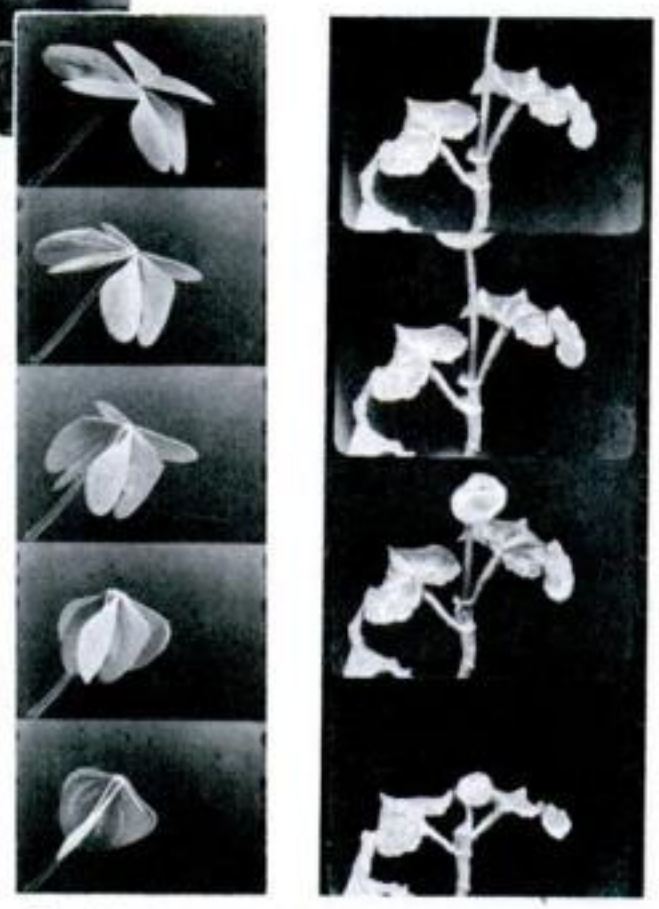
Left: How the neckerchief is tied in a "Tommy Atkins bandage" to bind a broken jaw until a hospital can be reached. The firemen say it is a perfect "nonskid" bandage for head injuries. When used as a tourniquet, to stop loss of blood, the kerchief saves numerous lives.

Another way of carrying an unconscious victim from a burning building. Here the fireman has tied the kerchief around the man's body. Many of the 50,000 needless deaths in the United States each year might be prevented, Red Cross authorities say, if every person carried a neckerchief for first aid, and knew how to apply it instantly in emergency.

Plants Star in the Movies

Amazing Dramas from the Lives of Flowers and Trees Enacted on the Screen—How New Camera Automatically Films Opening Buds or Breathing Leaves!

The "studio director," George E. Stone, focuses camera and lights on a group of his plant "actors."



Typical plant movie films. At the left, reading up, an oxalis reveals how it unfolds its leaves. Center: An ambitious begonia that grew right out of the picture. Right: Roots creeping through the soil in search of food.

Setting the master clock which controls the photographing of the plants at prearranged intervals.

WHAT no human eye can see—the movements of a plant as it grows—the all-seeing camera reveals in the modern wonder of speeded-up movies. In the latest developments of this process, the entire life history of a plant, including even the spreading of its roots, is caught upon a film by an automatic camera in an electric studio.

In his Los Angeles laboratory, George E. Stone, pioneer in plant photography, has developed the technique of the process to an amazing degree. Under powerful lamps the growing plants are the actors in this unique drama, while an automatic motion picture camera governed by a time clock winks at them from time to time and engraves an indelible picture of each stage in their career.

To indicate the principle of the process, a homely illustration suffices. From day to day a person may not notice the growth of the baby of the family; yet, when the observer returns home from a long trip, the child seems to have gained immensely in stature. So, in his plant-photographing room, Stone takes pictures of the plants, not continuously but at regular intervals that may be one minute or twenty-four hours apart, according to the subject. Meanwhile the plant has grown enough to show a difference. Imagine trying to use up a reel of film in a camera where it advances only three quarters of an inch, the length of a single picture, a day!

But if taking the pictures is a tedious process, it is not so with showing them. When the finished film is projected at normal speed, sixteen pictures a second, spectators see a plant's lifetime run off before their eyes. Some idea of the way the film is accelerated may be gained from the fact that if one exposure were made in the laboratory every four hours, it would take two and a half days to expose enough film to be shown in one second on the screen.

Sometimes the plants fool the camera and grow right out of the picture, as an ambitious begonia plant did in the center illustration. A choice flower bud occasionally opens outside of the picture; or it may fail entirely to open, while another opens out of sharp focus. It is necessary to outguess the plant to get a successful movie; and sometimes special charts of a fast-growing plant's previous growth are made before the specimen poses for its portrait.

A branch of a prune tree bursting into blossom, a cluster of oxalis leaves opening in the sunlight, and a mass of root tendrils seeking food in the soil are among the principal characters in a new film of the plant world that Stone is preparing. Another is an oak tree trunk that swells and shrinks daily, as revealed by a record that it traces upon a delicate measuring instrument. And there are tree leaves, too, which obligingly "breathe" through their tiny pores before the camera, and turn themselves away from the sunlight when it becomes too intense.

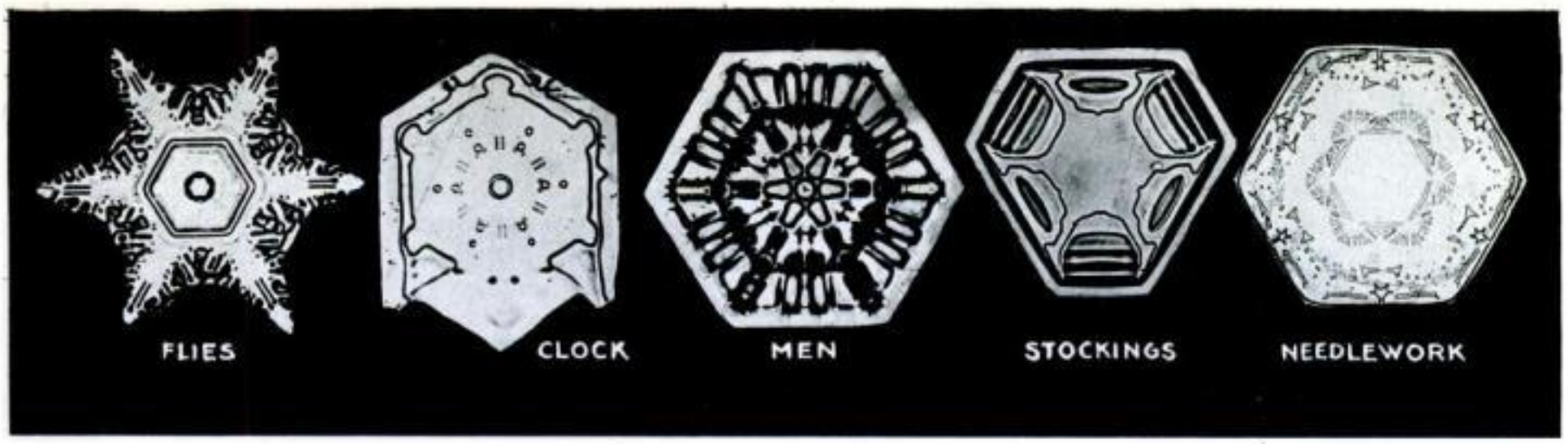
Stone's remarkable new apparatus avoids the unnatural expedient previously used in taking such pictures, of growing the plants in artificial light. A greenhouse especially designed for photographic work is his laboratory. Seeds and plants grow in a box at the center of this small glass room. The camera stands a few feet away, with powerful electric lamps on each side.

At short intervals along the glass roof are roller curtains, their cords attached to a "master" line. The entire set-up of lamps, camera, and curtains is controlled by an elaborate time clock and control mechanism on a special shelf above the door.

When the timer calls for a picture, there follows an impressive demonstration of automatic machinery. There is a click from the time clock and a whirring noise of an electric motor. Slowly the curtains are drawn over the windows and the room becomes dark. Another click, and suddenly the room is flooded with man-made sunlight from a 3,000-watt bank of lamps. All this takes but a second.

NOW the motion picture camera starts. It takes a single picture. Then the electric lights go out. The roof curtains roll back. Sunlight pours in again. The plant grows on, undisturbed, until the next picture.

Without human attention, this electric camera goes on taking pictures for days or weeks at a time, until it contains a roll of film that shows the growth of the plant from start to finish—a roll that will be run off on the screen in a few minutes' time.



Every Snowball an Art Gallery

FOR rare and fleeting beauty, the snowflake remains unchallenged by the artistic hand of man. Every one is a fragile masterpiece of Nature's craftsmanship—yet its real form would go unnoticed were it not magnified thousands of times.

With the aid of a powerful microscope and a camera, Wilson A. Bentley, of Jericho, Vt., in forty-four years has captured more than 4,000 of the elusive patterns. His newest and most striking snowflake photographs are reproduced on this page. No two are ever alike.

Strange likenesses appear in the crystals, when they are enlarged from sixty-four to 3,600 times! In the first of the five snowflakes pictured at the top of the page, for example, you may discern the hidden outlines of bluebottle flies. The second resembles an old-fashioned clock. Human figures lurk in a third. The fourth suggests a workbasket filled with stockings ready for darning, while the fifth is like a piece of delicate needlework.

Bentley's photographs have been bought by lacemakers seeking new designs. They have inspired jewelers to create new settings for precious stones and suggested novel patterns for wall paper. Once Bentley even sold snowflake photographs to a cracker manufacturer for models!

Some of the 4,000 crystal patterns photographed by Mr. Bentley. What strange likenesses can you find in them?

Keeping Pace with Aviation

Airport Lights Sunk in Ground

Lines of electric lamps, embedded in the ground so airplanes can run over them without danger, and radiating like spokes of a wheel from the center of an airport, are the latest idea for signaling wind direction and guiding planes to safe landing at night. Lieut. John S. Donaldson, of Jamaica, N. Y., is the inventor of the new beacons.

Laying a "Carpet of Light"

Above is a spectacular demonstration of a remarkable new floodlight designed by C. A. B. Halvorson of the General Electric Company to spread a "carpet of illumination" over an airport at night. Powerful beams from fourteen lamps of 3,000,000 candlepower are kept within four feet of the ground to avoid dazzling the eyes of landing pilots; yet the light is bright enough to read by. The lamps are set in a glass case mounted on a wheeled platform.

The new floodlight and its inventor. Within the glass case on wheels may be seen the fourteen powerful lamps.

The Airplane Junk Yard Arrives

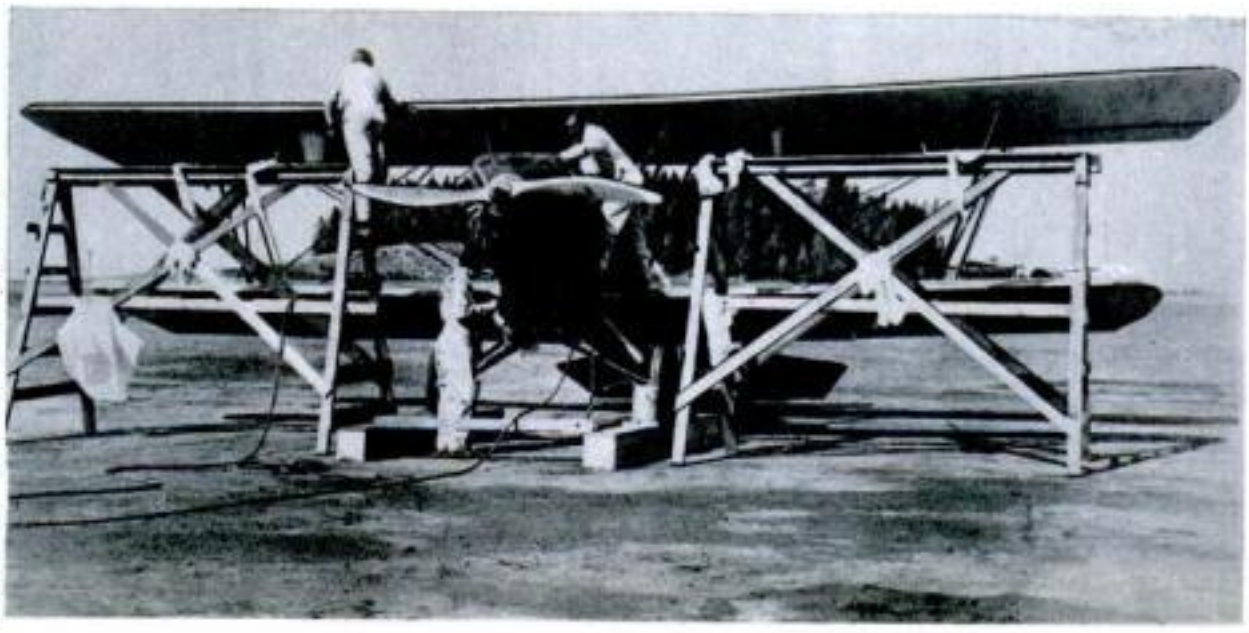
A sure sign of the popularity of air travel is this unique airplane junk yard in Los Angeles, Calif., where Arrigo Balboni buys up smashed planes and sells the parts. Here you can buy anything from a turnbuckle to a motor. The idea originated when Balboni cracked up his own plane and sold the parts for what he could get

When Army Blimp Takes Gas

The unusual photograph above shows the U. S. Army blimp *TC-8* being inflated with helium gas from one of the gigantic new Army tank cars described in last month's issue of POPULAR SCIENCE MONTHLY. On the car are mounted three tanks with a capacity of 206,000 cubic feet of helium under pressure of 2,000 pounds to the square inch—enough to fill the blimp. But it takes twelve carloads to inflate the huge *Los Angeles*

Airplane Service Stations, Too

Just like driving up to any roadside auto service station—you fly down to the new airport service station of the Aero Corporation of California, at Los Angeles, and there you can have your plane washed, greased, oiled, or repaired. The photograph at the right shows a plane being bathed and overhauled. This is said to be the first public station of its kind, and dozens of plane owners already have taken advantage of its facilities.

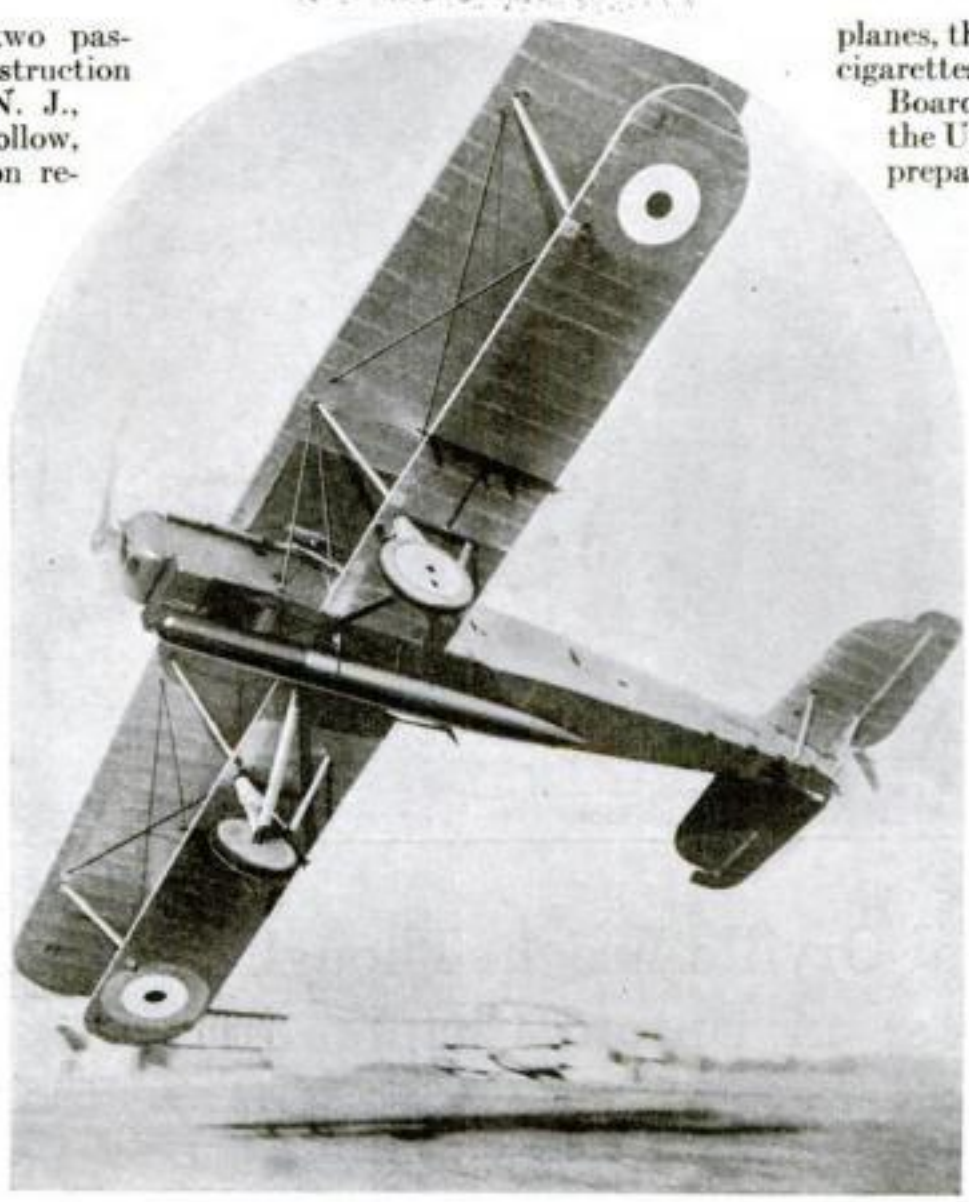


America's Largest Passenger Plane—Foghorns to Guide Air Liners—New Ideas for Flying Safety

AMERICA'S first thirty-two passenger plane is under construction at Hasbrouck Heights, N. J., and more are soon to follow, the Fokker Aircraft Corporation recently announced. These craft, with a wing spread of a hundred feet, will be the largest transport planes in America. They will be used on several of the new transcontinental lines now preparing for operation.

The planes can be equipped as aerial sleepers for night flying, accommodating sixteen berths. A buffet meal will be served from an electric kitchen, and the plane has a special navigating cabin below the pilot's cockpit.

Four propellers, powered by as many motors, are arranged in tandem fashion—one directly behind the other at each side of the plane.



A breath-taking moment during recent test flight of a new Hawker torpedo plane in England. With one wing almost grazing the ground, the great fighting ship banks low over the flying field. Beneath the fuselage may be seen a 2,000-pound torpedo which, it is said, could sink a battleship.

And Out You Go!

WHEN the pilot pulls the lever of a new parachute releasing device, passengers in an airplane have no option as to whether they will go or stay. Out they go, through trapdoors in the bottom of the plane, each one equipped with an individual parachute that opens automatically and lowers him safely to earth.

The device, which is being manufactured by a Trenton, N. J., firm, is intended to relieve a pilot of the responsibility of attempting to land a seriously disabled craft. Hitherto pilots have complained that in case of accident they cannot use the parachutes with which they are regularly equipped until the safety of the passengers is provided for—and the passengers, even if they have parachutes, are too timid to jump with them.

Now, if necessary, the pilot will unlock a safety lever that controls the new device and automatically drop out the passengers—either singly or all at once. When the last one is out, the pilot jumps.

A Foghorn for Airships

THAT foghorns may serve airships as well as vessels of the sea was demonstrated recently at Camden, N. J., where a new type of horn mounted on a city roof top guided the dirigible *Los Angeles* in a series of tests. The dirigible responded by flashing a light when it heard the sound. Eventually, according to the inventors of the horns, it is planned to install one at each of an airport's four corners, each sounding a different note, so that an air pilot approaching in the fog will know what course to hold to as he nears the field.

Unlike foghorns of the sea, the mammoth new sound projector casts a narrow beam of noise that resembles the beam of a searchlight, and helps an air pilot to check his direction. The horn is twenty feet long and ten feet wide.

Plane Plants Grass Seed

NOW grass seed may be planted from airplanes. Recently a 1,000-acre field in Coos County, Oregon, was successfully seeded from the air, at a third of the expense of hand seeding, and an excellent stand of grass obtained.

The plane flew over the field at seventy miles an hour, 500 feet above it. A lever in the hand of the pilot released seed from a specially designed hopper and allowed it to fall evenly upon a strip of land ninety feet wide. Following the successful experiment, large areas along the Pacific Coast may be similarly planted this year.

"No Smoking"—But They Do

LIGHTED cigarette stubs dropped from planes by aerial smokers constitute the newest and oddest of fire hazards, according to the National Board of Fire Underwriters. In wheat fields and stubble beneath air routes along the Pacific Coast between Los Angeles, San Francisco, Seattle, and Portland, as well as in the timberlands, there is grave danger of a serious fire from aerial incendiaries.

Despite "No Smoking" signs in the planes, the dropping of burning cigars and cigarettes continues, and the National Board is seeking the coöperation of the U. S. Department of Commerce in preparing regulations to end it.

An Amazing Stunt

WHAT observers characterized as a "square loop," a remarkable maneuver unknown in air history, was the unusual stunt performed recently at Curtiss Field, N. Y., by James C. Collins, test pilot, in a new Curtiss pursuit plane developed for the Navy. So abruptly did the ship swerve from horizontal to vertical that it produced a loop with very apparent "corners."

The machine is said to be the first two-place pursuit ship ever developed. A speed of 150 miles an hour in straight flight is claimed.

Better Roof Signs

HOW much chance has an aviator of reading a sign laboriously painted for his benefit on a roof top of city or town? About as much as you would have to spot a certain item among a hundred or so in a full-page newspaper advertisement, if you stared at it for forty seconds, says D. C. Young, aviation lighting specialist of the General Electric Company.

For that reason, he points out, a sign should be as large as a roof will permit. A six-foot letter cannot be read by a plane a mile high; a fifteen-foot letter is barely visible at two miles altitude. Moreover, the proportions of the letter must be well chosen so that a pilot can distinguish such features as the crossbars of an "E."

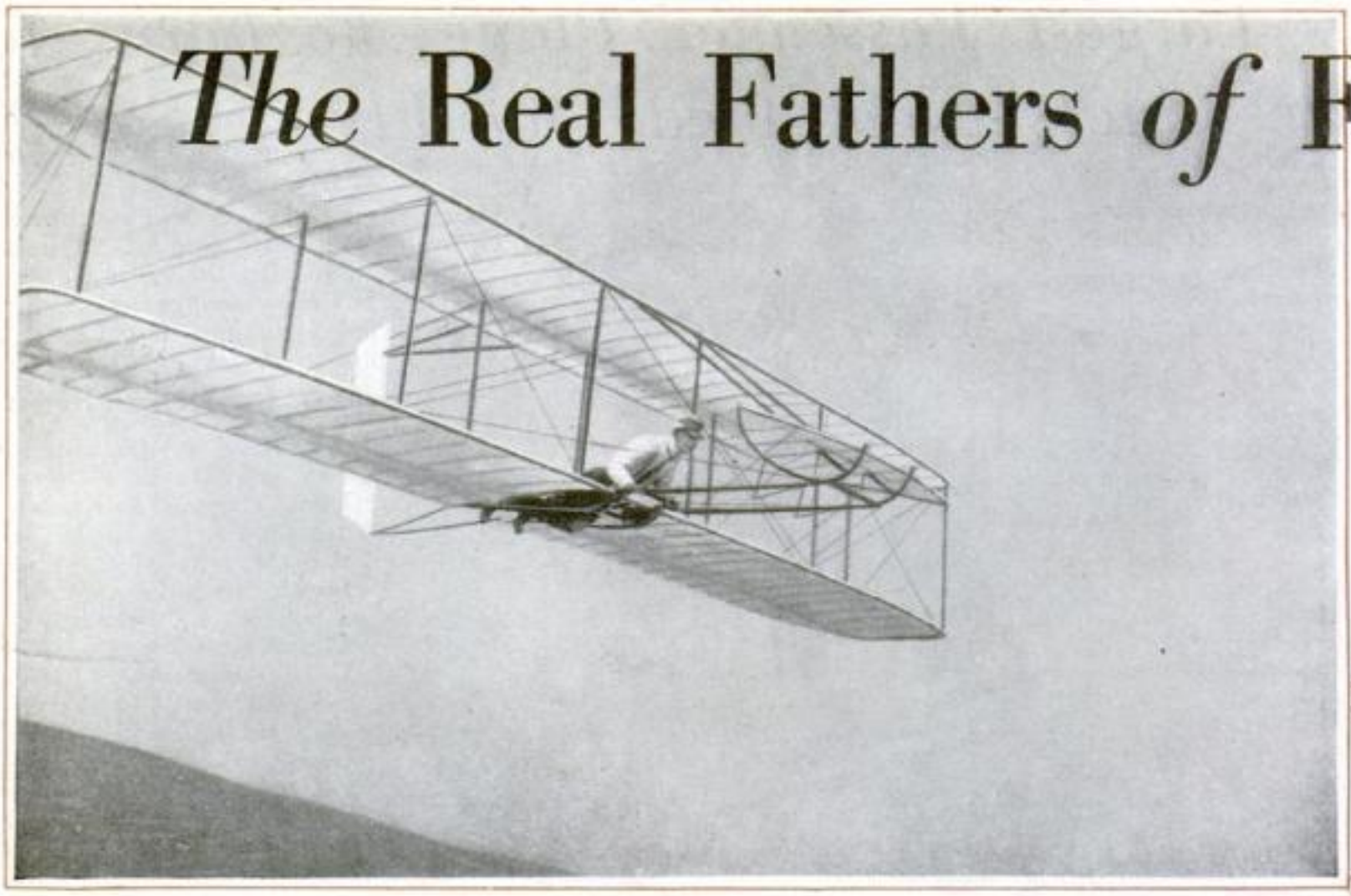
Chrome yellow letters on a black roof are advised by the Department of Commerce for best daytime visibility. At night the sign may be illuminated satisfactorily either by floodlighting means or by studding the letters themselves with electric bulbs.

Warns of Sleet on Wings

THROUGH a telltale detector mounted on the wing, a new electric thermometer warns a pilot that ice is about to form—one of the greatest menaces to aviators. In the pilot's cockpit a dial connected to the "ice-warning indicator" shows when the temperature is dangerously near freezing, and indicates whether it is rising or falling. By watching the instrument, a pilot can know when he should change his course to avoid sleet.

Another new electric instrument for airplanes is a fuel tank gage that measures the amount of fuel by its pressure on a diaphragm in the tank's bottom.

The Real Fathers *of* Flight



Wilbur flying the Wrights' third glider at Kitty Hawk in 1902. With this machine the air was conquered.

Wilbur scrubbed the grease from his hands, put on his good suit, and addressed the audience of scientists.

When Wilbur and Orville Wright Thought They Had Failed; an Untold Chapter in the Stirring History of the Airplane

By JOHN R. McMAHON

WHEN Wilbur and Orville Wright returned to Dayton from Kitty Hawk, N. C., after their first attempts to fly in a glider, they were about ready to give up their experiments in flying and devote their time entirely to their profitable bicycle business. This was at the end of October, 1900. When they thought of the few brief seconds they had spent in the air, of their glider abandoned as junk on the sands of Kitty Hawk, they wondered whether they had not been wasting their time on a hopeless quest.

But this mood did not last long. Within a week after their return the brothers wrote to Octave Chanute, saying they had entered the gliding game and had found some possible errors in his and Lilienthal's air tables. A friendly correspondence followed. Chanute was of French descent, lived in Chicago, and had high standing as a civil engineer. He had written a history of flying attempts, had planned various aircraft, and was credulous and kindly.

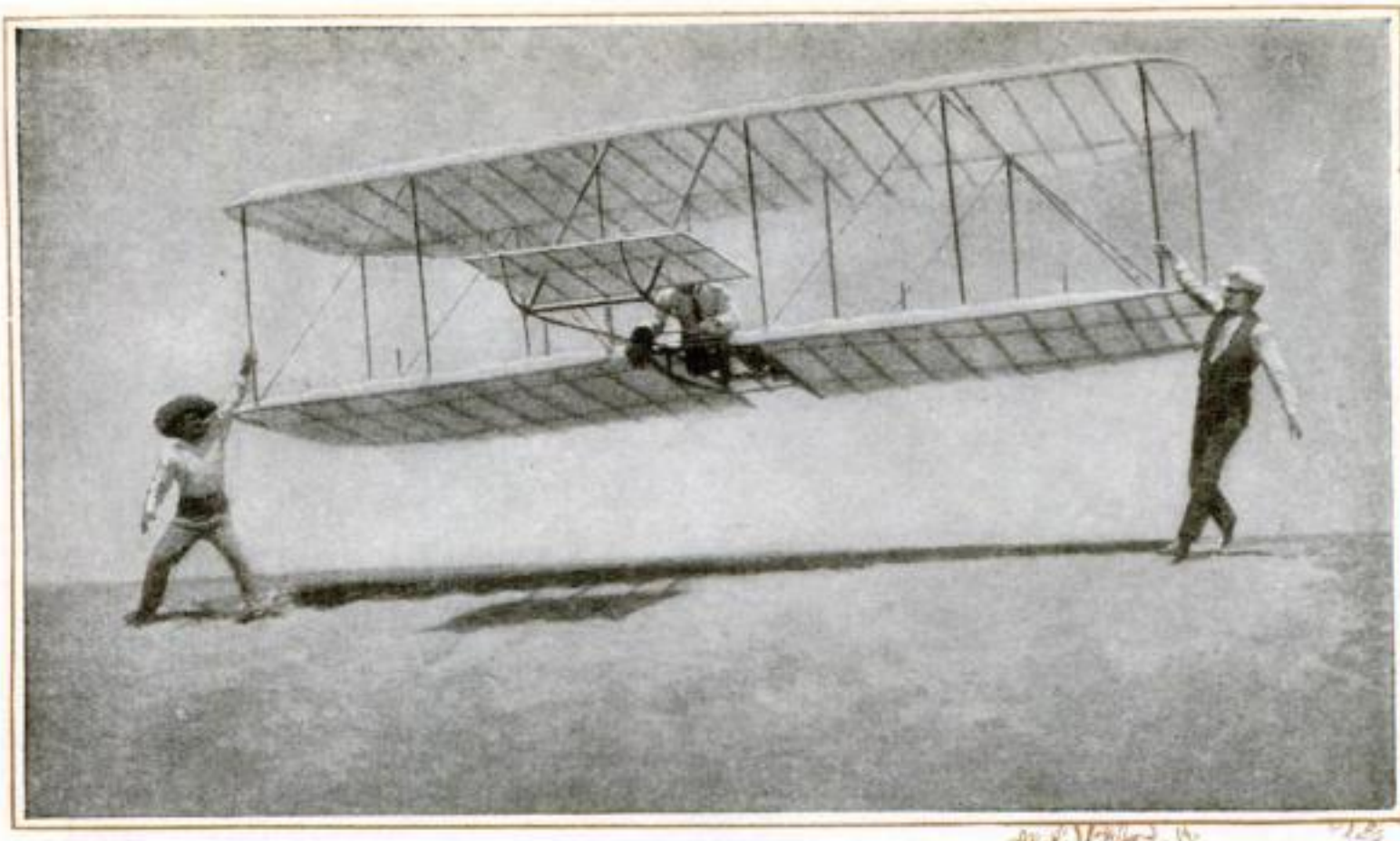
Soon the Wrights decided they could afford another vacation trip to Kitty Hawk next summer. How about checking up on those tables of air pressure before planning a new machine? The apparatus used by scientists to register air pressure on curved surfaces was too complicated and costly. Maybe a bicycle would help to reveal aerodynamic secrets. Put your testing device in front and pedal for all you are worth, one eye on the whirling telltale gadget, and the other—of course—on traffic. A bike meets air pressure of ten to thirty miles an hour. It is a perfect auxiliary in experiment and a little brother to the glider itself.

"Hiyi, mister! Lookit the windmill on a wheel!" jeered the boys of Dayton as Wilbur or Orville went by with a whirling wind vane on a rod projecting in front of the handlebars of his bicycle.

"Ha! ha!" chuckled grown-ups. "Does look funny to see a grown man playing with a kid's toy!"

Wilbur one day stood on a street corner watching his

Honoring the inventor. Lord Thomson (left), head of the British Aero Club, greets Orville Wright at Dayton, O., during twenty-fifth anniversary celebration of the first airplane flight. Right: Memorial shaft erected by citizens of Kitty Hawk, N. C., to mark the spot where Wilbur began building the Wrights' first experimental glider, forerunner of airplanes.



Launching the second glider of 1901 from Kill Devil Hill. This machine flew 389 feet, but it was still wild. Every flight was a perilous adventure, and at the end of the year Wilbur, discouraged, said gloomily to Orville, "Man won't be flying for a thousand years!"

The Wrights' first visit to Kitty Hawk was planned primarily as a vacation trip. They little realized camping and flying gliders would lead to mastery of the air.

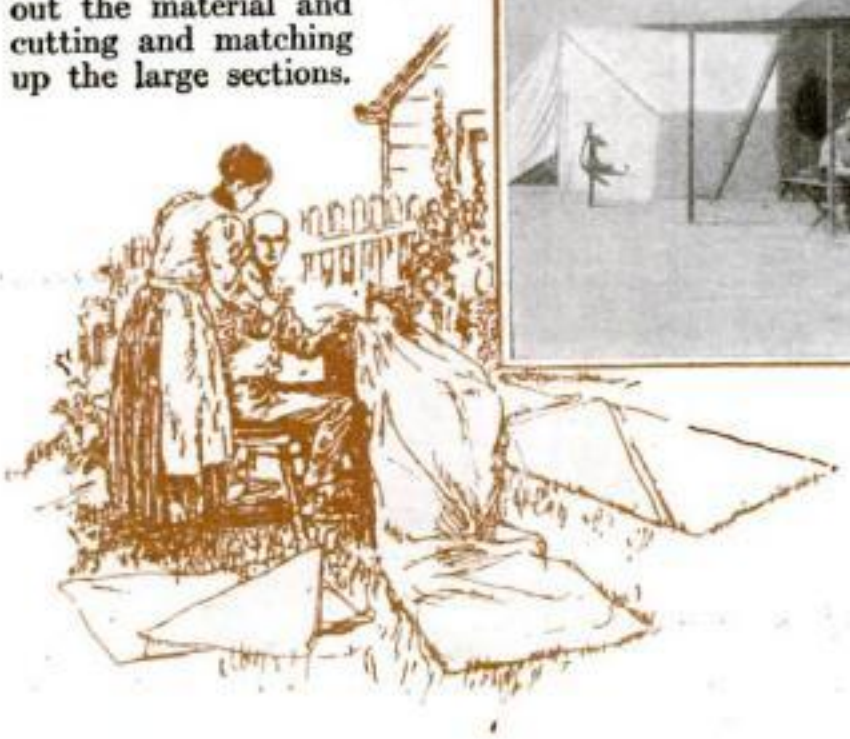
brother spurt past, when a stranger said:

"That fellow can run his gizzard out, but he'll never make that thing go up!"

The Wrights never learned the identity of this mysterious pessimist, who divined uncannily the purport of their quaint experiment.

THE windmill on the wheel shed little light on the problem of curves and pressures, so the brothers planned the new glider on the general lines of the old, but with greater lift. The wing curve was increased to one in twelve in accord with Lilienthal's table, while the area was enlarged to 308 square feet, making the glider about twice the size of most, if not all, predecessors. The wing span was twenty-two feet, the length with front rudder fourteen feet, and the height about six feet. It embodied the last year's device for warping the wings.

Soon Wilbur was absorbed in the task of stitching the wings of the new machine on the sewing machine in the back yard of their Hawthorn Street home. He had bought the material himself in a big local dry goods store. After many questions as to cloth weaves, quality, bleaching, and strength, he had ordered a large amount of "Pride of the West" muslin. The back yard lawn was convenient for laying out the material and cutting and matching up the large sections.



On the back yard lawn of their Hawthorn Street home, Wilbur cut out the muslin wings of the glider and stitched them on the sewing machine.

The cloth was cut at an angle or on the bias, so that its threads would cross the wing frames and act as a brace.

To lessen the hardships of last year the Wrights planned to have a shed instead of a tent at Kitty Hawk and to take along plenty of canned goods. A pitcher pump to get water in camp via a short pipe driven in the sand was "donated to the cause of science" by Charles Webbert, the plumber who was landlord of the brothers' bicycle shop.

Octave Chanute dropped into town to see the Wrights and, learning they were going soon to Kitty Hawk, told them:

"I have a man, E. C. Huffaker, who is building a glider for me in Tennessee. Suppose you let him camp with you. He'll help to handle your machine and you help to handle his or my glider. I have another protégé you might be good enough to take along. He's Dr. George A. Spratt of Coatesville, Pa. He is quite keen for an amateur in this flying idea.

The Wrights with their guests in the cabin camp near Kill Devil Hill in 1902. Wilbur is standing. Chanute is seated at end of cot. Beside him are A. M. Herring and Orville.

If you boys will board the Doctor I'll pay his railroad fare. You know a medical man is pretty handy in these experiments. I read a joke somewhere that an undertaker might be useful too. Ha, Ha!"

THE brothers agreed to the genial Chanute's proposal. They arrived at Kitty Hawk about July tenth and were joined in a fortnight by Huffaker and the medico. A shed of rough lumber was built near Kill Devil Hill. It was hangar, workshop, and home for four men. The pump with sand-driven pipe supplied good water. Orville, as chief cook, tended a gasoline stove and laid out a model kitchen with eggs of numbered sequence in a rack and canned goods mathematically assorted on their shelves. The camp was perfect except for a long hour's trudge through ankle-deep sand for mail and extra supplies, and a plague of innumerable ferocious mosquitoes.

Dr. Spratt was a good story-teller. Huffaker was all right, too, but absent-minded as to dish-washing and other domestic chores. Chanute made a week's visit, observing the Wright machine; his own partly built glider on which Huffaker was working had been wind-wrecked the night before Chanute's arrival, around August fourth.

Postmaster Tate and his brother Dan took a hand with the others in helping to launch the Wright glider. Wilbur was aboard the first trip on July twenty-

seventh in a thirteen-mile wind down Kill Devil Hill, with Orville and Spratt at the corners. The machine quickly nosed to earth. The rider crawled back in repeated trials inches at a time until his weight was about a foot to the rear of the first position. Then he sailed off neatly for a distance of more than 300 feet.

THE gallery applauded but the inventors were disappointed. They saw the glider's tendency to nose dive and to stall backward. The machine of last year had acted better with a fraction of the present use of the front rudder.

Once Wilbur was saved in the nick of time from a perilous stall by the warning yell of Orville on the ground: he turned rudder and shifted his body so as to make a safe descent.

"Those air tables must be wrong, as we thought last year," agreed the brothers. "The wing curve is too great. We'll truss the ribs and make the curve less."

The glider thereby became as well behaved as last year, flew 389 feet over heights and hollows, and held up well against a breeze of twenty-seven miles an hour. But this was not enough. The machine was yet too wild and inefficient for the exacting owners, who measured its pull against a pair of scales and computed factors of area, weight, shape, angle, and wind-speed with a high degree of mathematical skill.

The unpublished diary of the Wright brothers, of which the more pertinent passages are before me as I write this article, has an entry of some 600 words under date of July 30, 1901, which weighs the pros and cons of their work thus far and conveys an undertone of dejection.

THEY stopped gliding on August seventeenth and started home.

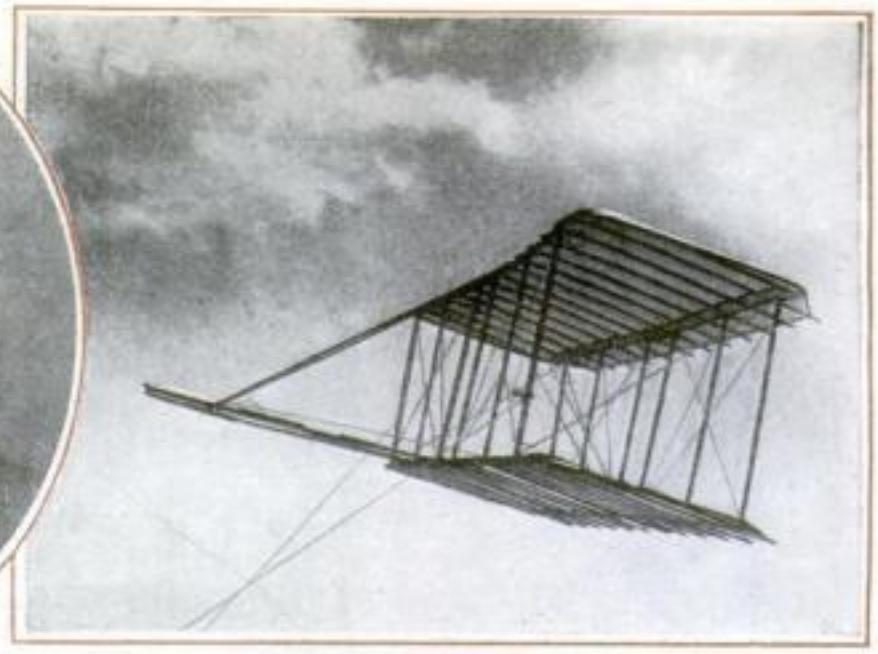
". . . We doubted that we would ever resume our experiments," Wilbur stated later. "Although we had broken the record for distance in gliding . . . and although Mr. Chanute . . . assured us that our results were better than had ever before been obtained, yet when we looked at the time and the money which we had expended, and considered the progress made and the distance yet to go, we considered our experiments a failure."

More tersely Wilbur at the time said to Orville:

"Man won't be flying for a thousand years!"

The younger brother was more hopeful by nature and perhaps hummed, "Wait Till the Clouds Roll By," or cited a text on moving a mountain by faith.

McClure's Magazine for September was on the news stands when the brothers got home and they found in it a cogent



The first experimental glider built by the Wright brothers in 1900, being flown as a kite to test it. Inset shows Wilbur at the age of 22, when he was editor of a weekly paper.

In the Dayton bicycle shop Wilbur and Orville built the world's first wind tunnel, with which they made their epochal discoveries in aerodynamics. A homemade metal fan, driven by a gas engine, supplied the air blast.

discussion of the flying problem by Prof. Simon Newcomb, world-famous astronomer and mathematician, who weightily corroborated the temporary despondency of Wilbur. Basing his profound analysis on calculus, logarithms, fluxions, harmonics, and whatnot, the eminent savant tried to put a quietus on the vain dreams of bicycle men and other fanatics in these words:

". . . the construction of an aerial vehicle which could carry even a single man from place to place at pleasure, requires the discovery of some new metal, or some new force."

Perhaps the learned professor was right in a way. Since no new metal was available, the creation of the airplane within the next couple of years might be attributed to the discovery of a new force—the elemental genius of Wilbur and Orville Wright.

It is darkest before dawn. If Wilbur had been a seer he would have amended his own discouraged statement:

"Man won't be flying for a thousand years—I mean, Orv, not for about 845 days."

The brothers did not know, of course, that in their discovery of the wing warping principle, evolved by Wilbur from a twisted pasteboard box after Orville's concept of hinged wings, they had solved twenty-five percent of the flying problem. They were on the straight road to victory but could not see it. Happily, they were pessimistic and instead of gloating over their record as the world's champion gliders, applied themselves to a deeper and more searching study of the unknown.

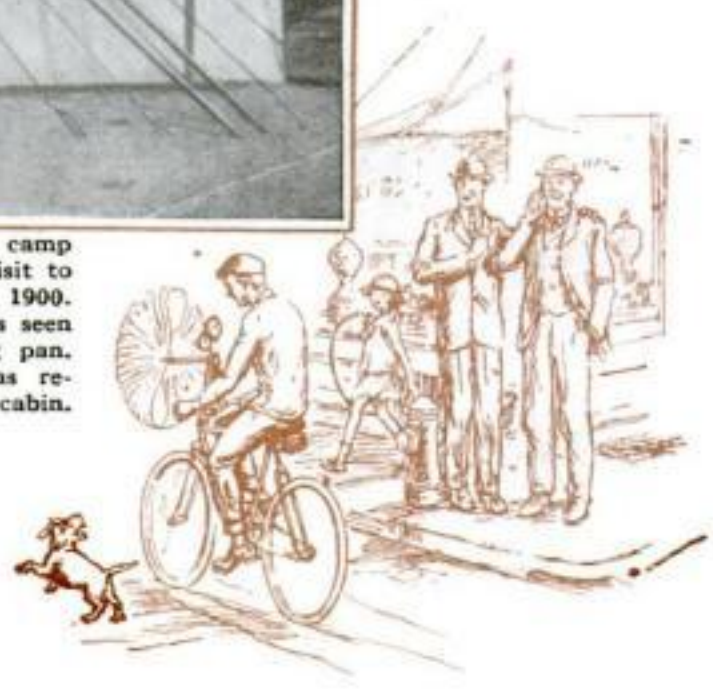
They focused their minds on the puzzling incorrectness of the classic air tables. These tables pretended to give the right curves of wings. Yet the last glider, curved after Lilienthal's rules, had about one third the expected lift or weight-carrying power.

OCTAVE CHANUTE, as president of the Western Society of Engineers, asked Wilbur to address that body at their Chicago headquarters on the subject of aerial experiment. The bicycle men were put on their mettle and perhaps even awed. What an august audience of scientists! Be careful! Check up everything! Well, here are the facts, whether the scientists like 'em or not.

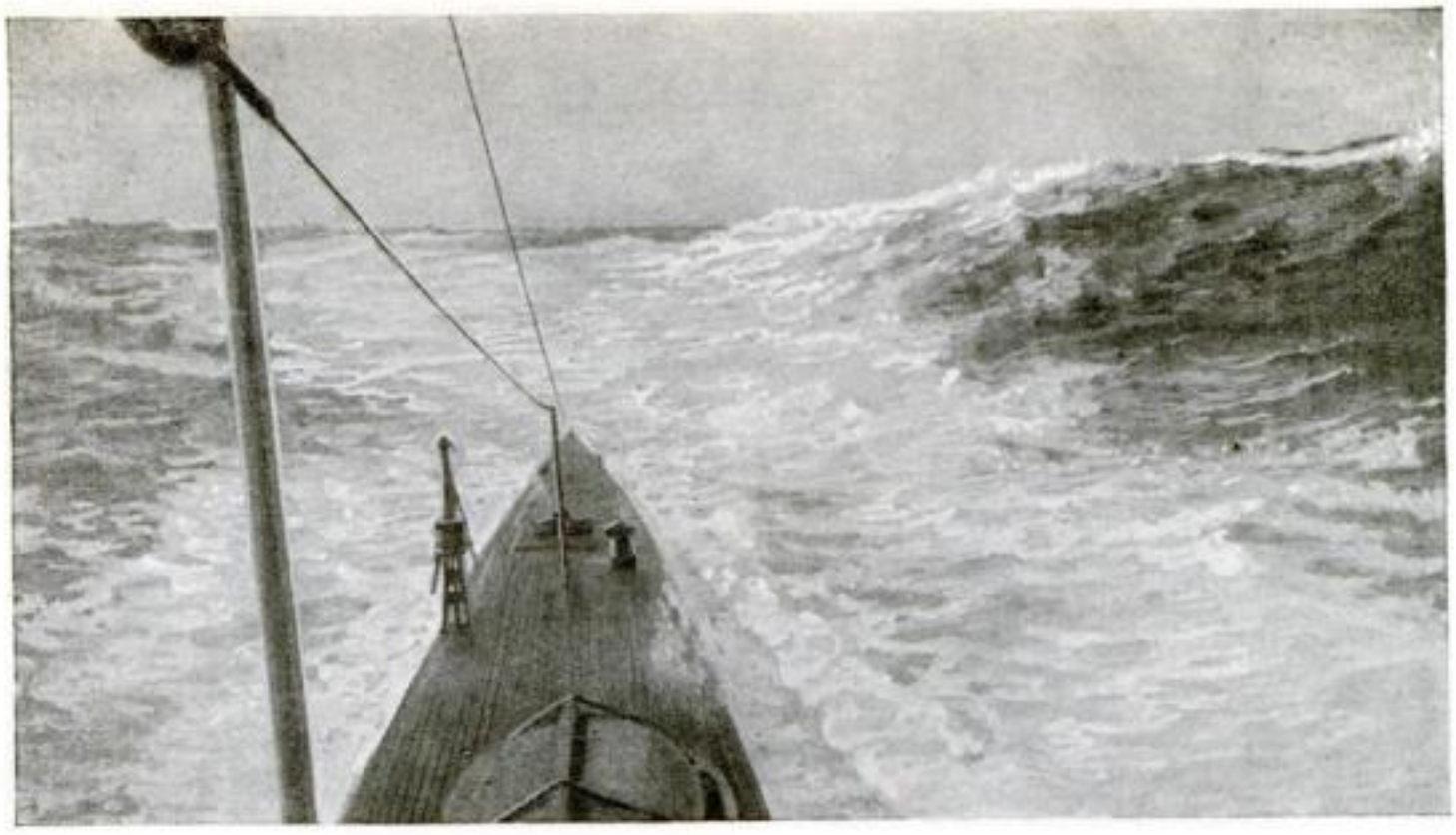
Wilbur scrubbed the grease from his hands, put on his good suit, and with a carefully written address in his pocket took the train for Chicago, where he was

(*Continued on page 142*)

The Wrights' tent camp during their first visit to Kitty Hawk in 1900. Orville, the cook, is seen scouring the frying pan. Later the tent was replaced by a wooden cabin.



"Lookit the windmill on a wheel!" jeered the townsfolk as Wilbur or Orville rode by with a wind vane on the handlebars.



The *S-21*, U. S. Navy submarine, bucking the big billows rolling over the under-the-sea cradles of earthquakes.

Hunting Quakes in a Submarine

Here Is a Jules Verne Romance up to Date—A Story of the *S-21's* Amazing Discoveries at the Bottom of the Sea

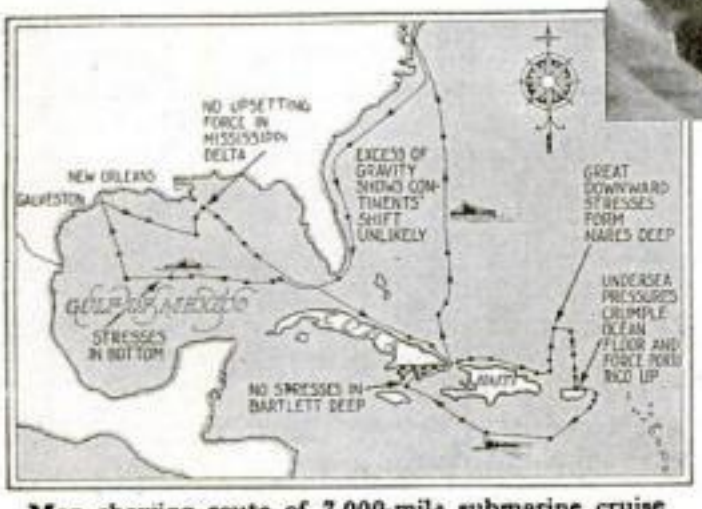
Dr. F. A. Vening-Meinesz, seismologic experimenter, tending delicate pendulums on ocean's floor.

By NORMAN C. McLOUD

BACK from an undersea cruise through the Gulf of Mexico and the Caribbean Sea is Dr. F. A. Vening-Meinesz, of Holland—the first man to hunt earthquake nests with a submarine.

Forty-nine times the U. S. Navy submersible *S-21*, with this Dutch expert aboard, dove to the bottom of the sea to allow him to weigh the earth beneath with his delicate gravity pendulums.

He found the fears of geologists that the Mississippi's silt, piled up to form a delta, may cause a terrible earthquake were groundless. But in the Gulf of Mexico Dr. Vening-Meinesz discovered a veritable hotbed of quakes, which either a slow, deliberate readjustment or a colossal temblor will eradicate sometime.



Map showing route of 7,000-mile submarine cruise in search of earthquake nests. Dots indicate dives.

Left to right: Dr. Fred E. Wright, of the Carnegie Institution; Dr. Vening-Meinesz, and Elmer Collins, naval hydrographer, on the submarine *S-21's* deck.

And north of Porto Rico his instruments revealed a mighty force buckling the undersea crust and forcing that island upward. Also, he announced, his tests tended to contradict the recently-advanced notion that North and South America are drifting westward.

These things he told a distinguished group of experts at a recent meeting of the Washington Academy of Sciences, the U. S. Navy Department, and the Carnegie Institution—a hastily arranged lecture to acquaint American scientists with his methods before he sped back to Holland.

Like one of Jules Verne's romances is the story of this man's travels beneath the sea on a 7,000-mile cruise. Learning of his desire to solve the subterranean mysteries of the Caribbean, where many earthquakes occur, the U. S. Navy placed the *S-21* at his disposal. Into this small floating laboratory, the six-foot-seven scientist squeezed himself and a unique instrument of his own invention—three double pendulums in a special case.

For weeks the *S-21* cruised the Caribbean and the Gulf of Mexico while the expert discarded dignity and sat cross-legged on the *(Continued on page 148)*

If you could look behind the microphones of a radio comedy, you would see simply a group of actors, in everyday clothes, aided by ingenious contrivances that produce almost any noise.

When the Radio Lion Roars

Or a Mouse Squeaks, It's an Ingenious Invention behind the "Mike"—A Story of Life in the Broadcasting Studios

By EDWIN W. TEALE

THE other day a boy called at one of the country's big broadcasting stations. He wanted a job for his pony.

"What can the pony do?" asked the casting official.

"Well, sir," said the boy earnestly, "I've trained him to tramp up and down whenever I give a signal. When you need the sound of hoofbeats in a program, he'll make them!"

"That's an idea," said the official, "but we already have a pony—one that requires no attention and never eats."

The boy was led to a room that made his eyes grow wide with excitement. It was filled with noise-making devices—instruments that could reproduce almost anything, from the roar of a jungle lion to the whistle of a Mississippi steamboat.

"Here's our pony." The man picked up two halves of an empty cocoanut shell. "Listen!" Holding them open-side down, he struck the top of a table in a staccato series that sounded exactly like the "clopp, clopp! clopp, clopp!" of a galloping horse. "That," he explained, "is the way hoofbeats are made in a radio studio."

Swanee Taylor, "Sneeze and Snore Man" of radio. He makes sixteen kinds of snores.

Few of us as we listen day after day to the radio realize the amazingly simple devices which create many of the sound effects we hear. Recently I learned the secrets of some of them when I spent several days watching life behind the microphone in three famous broadcasting stations, WOR, WEAF, and WJZ. WOR is the key station of the Columbia Broadcasting Company network. WEAF and WJZ form the heart of the Red and the Blue networks, respectively, of the National Broadcasting Company. Their programs are heard from coast to coast. In their studios I met people who had been only voices to me before, and I saw any number of strange mechanical creatures whose sounds spring to life across the ether.

At WOR, Leonard E. L. Cox initiated me into the mysteries of the radio mouse. Cox, a lean ex-cowpuncher and soldier of fortune, plans, writes, and produces sound spectacles for his station. He showed me how the most lifelike imitation of a mouse's squeak is made by rubbing a dampened finger tip along a pane of glass.

"THE sound of waves," he told me, "is made by putting sand and gravel on the head of a drum and stirring it periodically with the hand. The 'moo' of a cow is produced by blowing through a long tube in a peculiar manner. In one of our recent features, 'The Retreat from Moscow,' the distant boom of cannon was imitated by dropping empty five-gallon gasoline cans on a table top. That was the explosion, while the faint rolling of a drum gave the impression of reverberations. For the clank of armor we discovered that brass chains, similar to those used to hang chandeliers, gave the precise effect we were after.

"Here in the studio we have one rock-

But as you lounge in comfort, enjoying the comedy, the voices and music from the loud-speaker conjure up some such scene as this. And you find that as you listen you can almost see the quaint characters portrayed.

ing chair that plays a part in many productions. It has a peculiar squeak. Over the radio it is the exact reproduction of the creak of an old farm wagon. We have even discussed insuring that chair against losing its squeak!

"The radio lion is a simple device with rosined string. When the string is pulled, the 'lion' roars. Of course, a number of radio effects are made by ventriloquists. We once broadcast a man who could put on a five-man fight all by himself. Recently, we tried a unique experiment in presenting a war scene. We had five phonographs with electric pick-ups, so that the different records of battle sounds were played at the right moment."

"BABY-CRY instruments," often used on the stage, are unsatisfactory before the microphone, I learned. Over the radio there can be no baby in sight, as on the stage, to aid the illusion. And so WOR has a "baby-cry woman" under contract. She is Beatrice Moreland, an actress who has made a specialty for years of imitating children. She can reproduce the wails of infants of all ages, and that is practically all she does. Imagine drawing a salary for doing nothing but making sounds like a crying baby!

"Uncle Don" Carney, another radio performer, worked for weeks learning to imitate a seal. He hung around the seal pen at a zoo until he could imitate the animals so cleverly that he fooled even the keeper. He snorts and slaps his vest before the "mike." To the listener, it sounds just like a seal emerging from the water, flapping its fins.

But even queerer is the job of Swanee Taylor, famous "Sneeze and Snore Man." Taylor is a licensed aviator and a former Army airman. One night, during the war, he was unable to sleep. He tossed on his bunk, listening to his buddies perform in a wide variety of snores. At last, in desperation, he began imitating them to pass the time. Next day he repeated them for his friends. They shouted their applause, and Swanee was started on his snoring career.

For a dozen years he has practiced, adding to his collection, and branching out into sneezes as well. Now he has a repertoire of sixteen kinds of snores and ten types of sneezes which he performs before the microphone with all the seriousness of a judge addressing a jury. He has listed some of his pet snores as follows: The inspirational, or common, snore, so named not because of any uplifting effect upon the hearers but because it is made with an inspiration or indrawn breath; the troubled conscience snore, the airbrake snore, the whistling bomb snore; and the acme of all snores, the inspiration-exhalation, which is described as a rising and falling sound with the putt of a motor boat at the end!

EVERY evening some forty million Americans listen to the radio. Yet just what goes on in the broadcasting studios remains a mystery to most of us. The author of this fascinating article takes us behind the "Mike" in a number of the big stations, shows us amazing instruments, introduces us to the clever people who entertain, and answers many of the questions everyone has wanted to know.

INTO one of the studios, a few weeks ago, walked a man who owned six prize birds. He was positive that his birds would make a hit on the air. But, he explained, they were temperamental. So he wondered if it wouldn't be a good idea to run an extension to his room, set up a microphone, in front of the birds' cages, and then wait until they felt like singing!

That suggestion reveals a common misconception of how radio programs are prepared. Everything is arranged to the minute, weeks in advance. For the country-wide chains between three and four hundred programs are worked out long before they are scheduled to go on the air. The "continuity"

(Continued on page 161)

Back of the Month's News

Niagara Falls in winter—a magnificent spectacle of frozen power. Experts are seeking to preserve this masterpiece of beauty while withdrawing more of its water for power purposes.

By
KARL VOOGHT

A CHICAGO dentist, Doctor Hilton Ira Jones, recently got into the headlines by announcing that our Government has a gas so powerful that it can destroy whole armies. This gas, called cacodyl isocyanide, is said to be known to all the principal nations, but whether it will ever be used is a question.

What Dr. Jones had in mind seems to be the so-called "mystery gas," said to have been manufactured during the war in a factory near Cleveland, known in Army circles as the "mousetrap." Great secrecy surrounded the reported production of this gas. Every man who went to work in the "mousetrap," so the story goes, was required to sign an agreement not to communicate with anybody outside of the plant until the war was over. Many of them were not even allowed to let their families know where they were. With every possible comfort, the workers were confined under guard in the "mousetrap" until the war was over. Then every trace of the plant and its contents was obliterated.

"I WAS more than delighted with your new pages of brief comment on the news of the month," a reader writes. "I find this unusual feature by Mr. Vooght as entertaining as a book of short stories."

We hope you like it, too. And we hope that by your criticism you will help us make this new feature of POPULAR SCIENCE MONTHLY the most interesting and useful ever published.—The Editor.

IF THIS gas ever was made, none of it ever reached the front. People who claim to know assert that soon after the Armistice all the mystery gas, except small samples for experimental purposes, was loaded in metal drums on a freight train. Leaving Cleveland after dark one night this train was given the right of way to Baltimore. There the drums were loaded on a waiting ship which immediately put to sea. Two hundred miles out in the Atlantic the terrible gas was dumped overboard in two miles of water.

Workmen employed in the manufacture of the gas necessarily wore specially devised masks and protective gloves and clothing. It has been said that a workman summoned to the office of one of the officers in charge rested his gloved hand for a few minutes on the back of a chair. According to the story, the officer sat in that chair for an hour or two thereafter, felt a burning pain between his shoulder blades, summoned a surgeon, and was immediately put under medical treatment. He died, however, within twenty-four hours, from exposure to the chemicals which the workman's glove had transferred to the back of his chair!

While the "mystery gas" is supposed to be an American invention, the secret of its formula, according to Dr. Jones, has leaked out and is in the possession of European nations. It is said to be easy and cheap to manufacture in large quantities and at great speed from materials easily obtained everywhere. During the war the United States is believed to have held the gas for use only as a last resort in case of need.

Our Government has always refused to subscribe to any international agreement prohibiting the use of gas in war, on the ground that it is more merciful than cannon or bombs, since its purpose is not to kill but to incapacitate.

Saving Niagara's Grandeur

THE international board created, by the United States and Canada, to consider means of preserving the scenic beauty of Niagara Falls, has reported that submerged dams of rubble stone built at strategic points in the upper river will keep a thin veil of water flowing over the falls and permit the withdrawal of more water for power purposes from the upper river.

At Niagara more than 200,000 cubic feet of water a second plunges in one sheer drop of more than 150 feet. That is enough water, falling from the height of a fifteen-story building, to flood Manhattan Island thirty feet deep in a day's time! That the falls may not go "dry" only about one third of Niagara's power is now being used on both sides of the river. The ice bridge which forms below the falls every cold winter is one of the most interesting of their scenic attractions. It is often possible to walk out on the ice bridge close enough to the falls themselves to get a cold shower bath. And every winter the spray, freezing as it falls, forms pictures of marvelous beauty which change their shapes from day to day.

Men now living remember when the Horseshoe Falls were nearly 400 feet nearer to Lake Ontario than they are now. From 1843, when measurements first began, to 1906, the Canadian Falls receded 335 feet, or at the rate of five feet a year; since 1906 the rate of recession has been only about half that. This is due to the erosion of the soft shale which underlies the limestone which forms the lip over which the water falls. As that is cut away by the whirling waters at the

Absorbing Bits of Romance, Wonder, and Adventure Behind the Discoveries and Conquests of Science

base of the falls the limestone is undermined and drops into the gorge in huge chunks. The limestone is thicker on the American side of Goat Island than on the Canadian side, so that there is less change in the position of the American Falls.

Danger in Short Radio Waves?

EXPERIMENTING with short-wave radio telephony between Schenectady, N. Y., and Australia, engineers of the General Electric Company found that everyone who came into the path of the waves experienced a sensation of "feverishness." Tests with an ordinary clinical thermometer showed that the temperature of one of them, during fifteen minutes of exposure to the short waves, rose from the normal 98.6 degrees to 100.8. All showed temperature rises varying with the individual.

Is there a menace to human life in these short waves? Not only are they now being generated for broadcasting and communication purposes from many stations, but they are being set up by all sorts of electrical discharges, wherever electrical machinery is operating.

Whether the induced fever is injurious to those exposed is under investigation. Experimenting with rats and dogs at the Albany Medical College, Dr. H. R. Hosmer reports that unless the exposure was intense and prolonged there seemed to be no after effects, even though a body temperature equivalent to ten or more degrees of fever has been induced.

As a means of treating disease, short radio waves offer interesting possibilities. Physicians have obtained remarkable results and complete cures in the treatment of general paralysis by artificially produced fever. Patients suffering from paralysis have been inoculated with the malaria germ, which causes a mild fever and is itself controlled by the usual treatment for malaria. If an artificial fever which does not itself set up a harmful condition can be safely induced in human beings by radio, medicine has a new tool to work with.

Mysteries in the Moon

A BOY arrested for theft in an English village recently set up the novel plea that he was a victim of "moon-madness," and that every four weeks, at a certain stage of the moon, he went mad and was not responsible for his actions.

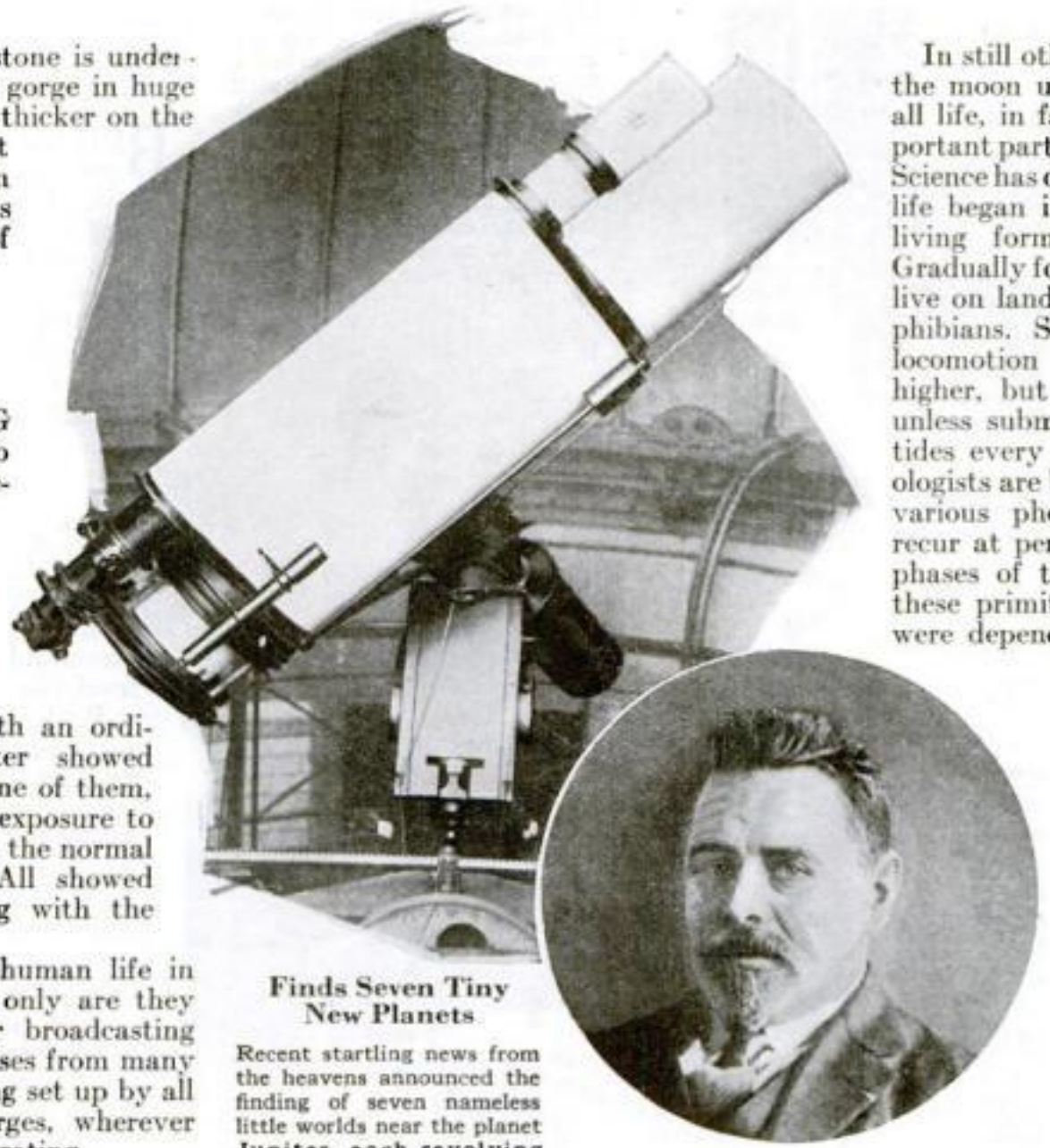
The case has revived scientific interest in old beliefs about the influence of the moon. The very word "lunatic," applied to an insane person, indicates the once general belief that madness resulted from the influence of Luna, the moon; idiots are often referred to in old literature as being "moonstruck." Farmers once generally believed that seed planted in the dark of the moon did not germinate as well as when planted at full moon, and many still hold to that belief, long denounced as a mere superstition.

The possibility that there is more than superstition in the idea of the moon's influence, however, is borne out by some recent scientific discoveries and observations. The light which reaches the earth from the moon is sunlight, to be sure, but it is reflected sunlight, and light reflected from the surface of a sphere becomes polarized. That is, the path of the light rays is twisted. Experiments with seeds exposed to polarized light prove that they actually do germinate more sturdily than those not so treated, indicating that the old farmers' notion has a scientific basis. It is entirely possible that susceptible persons falling under the influence of polarized light may be affected. The influence, though slight, might even be sufficient to disturb the delicate balance between sanity and insanity in "borderland" cases.

In still other ways the influence of the moon upon human lives—upon all life, in fact—is traced as an important part of our racial inheritance. Science has definitely established that life began in the sea. The earliest living forms were sea creatures. Gradually forms evolved which could live on land between tides, the amphibians. Some developed means of locomotion on land and climbed higher, but still could not survive unless submerged by the full-moon tides every twenty-eight days. Biologists are beginning to believe that various phenomena of life which recur at periods represented by the phases of the moon trace back to these primitive forms of life which were dependent upon the action of the moon upon the waters, causing the tides.

All of which raises the question whether planetary light rays may not have some effect upon life on earth, though no serious person of scientific attainments will concede that those effects, if any, are such as have been claimed by astrologers, ancient and modern.

Certainly we are beginning to learn that it is not safe to say that any widely held belief is untrue merely because no scientific basis for it has yet been discovered. The great men of science take no such view.



Finds Seven Tiny New Planets

Recent startling news from the heavens announced the finding of seven nameless little worlds near the planet Jupiter, each revolving about the sun as does our earth. Here are pictured the man and his remarkable instrument responsible for the discovery. The astronomer is M. Delporte, of the Royal Observatory of Belgium, and the instrument is a huge star-mapping telescope known as an "astrograph," which automatically records photographs of new heavenly bodies and charts their positions. Astronomers say there are nearly a thousand tiny planets swinging on their orbits between Mars and Jupiter. The largest of them is believed to be not more than 20 miles in diameter.

Seeing Like the Birds

BARON C. SHIBA, a young Japanese, has just perfected a motion picture camera which takes 20,000 pictures a second. His camera works so fast that it takes twenty minutes to show on the screen all the pictures photographed in one second.

Ordinary motion pictures are taken at a speed of sixteen a second, the speed which, experiments have shown, best depicts normal motion. A lot can happen in a sixteenth of a second, as the slow motion movies prove. When we see pictures taken at speeds up to two or three hundred a second and shown on the screen sixteen to the second, we discover that the running horse or the pole vaulter goes through many motions which the unaided eye or the ordinary movies do not detect.

The Japanese high-speed camera was designed to study the flight of birds in the hope of learning something useful to aviation. Pictures taken and projected at sixteen to the second explain many things which were never before understood about how birds fly, particularly how they rise and fall on air currents with just the slightest movement of their wings, or none at all. The bird's eye

Creates "Chemical Man"

Ship news reporters who met Dr. Benjamin Gaylord Hauser, American physician, on his recent return from Europe, found him accompanied by a strange companion in the form of a glass man, filled with tubes and retorts of chemicals, representing the digestive organs of the human body. Dr. Hauser is seen at the left with his creation, designed to demonstrate to medical students the intricate chemical processes of digestion. With it he shows, for example, how the laboratories of the body make and use three pounds of saliva and more than ten pints of gastric juice daily.

detects air movements too rapid to register on man's retina, and it sees clearly what to us is practically invisible. But the new high-speed camera actually shows the air currents themselves on the screen-swirling, rising, and falling just as the bird sees them.

Men will never learn to fly like the birds until they can see like the birds and take advantage of the motion of the air, as the birds do. This discovery may some day be applied to aviation by optical devices to speed up and magnify the aviator's vision so that he can tell when he is approaching a strong upward or downward air current. At present he has no way of knowing until his plane is caught in a "hole in the air," which he might have avoided if he could have seen it.

Ancient Words Still Live

SOMEWHERE in our atmosphere, an official of a broadcasting concern told an Atlantic City audience, the words spoken by Moses when he come down from Mount Sinai are still vibrating. If they could be recaptured they could be heard today.

Theoretically that is true. What we know as sound is merely vibration. Vibrations once set up do not cease. They become fainter and fainter but never die. The difficulty in picking them out of the air is one of mechanics. But there is not standing room on the earth for the series of microphones and amplifiers needed to recapture the faint vibrations of words spoken only yesterday.

It is possible, though hardly worth doing, to recapture sounds several minutes after their vibrations have ceased to be audible, especially if they have been originally produced between hard walls which echo them back. Soft plaster, hangings, furnishings, and recesses in a room absorb and deflect the sound waves; hard plaster walls in an unfurnished room reflect the sound waves from one wall to the other and back again. That is why every noise in an empty house sounds so much louder than in a room which is furnished, and especially if it is full of people.

The most persistent echoes are to be found in the Swiss Alps, where the voice is reflected from one rocky cliff to another and words can be distinguished for several minutes after they have been spoken. In the Kootenai Mountains of Montana there is an echo which is said to reflect sound for seven minutes, before the waves become too faint to hear. It probably would be easy enough to pick up and amplify the sound waves under such conditions perhaps an hour after they had died out, but hardly worth doing.

The sound of the human voice, translated into electric vibrations, can be stored up in magnetized steel wires and released at any time, just as it can be stored on a phonograph record. It can be slowed up for several seconds and then automatically released, which is done in some cases in long-distance telephony. It can be picked up and amplified, as in radio telephony. It can be "scrambled" so that the radio waves transmitted across the ocean form syllables which cannot be pieced together at the receiving end except by an "unscrambling" device.

But nobody yet has tried, and probably nobody ever will try, to recapture Lincoln's Gettysburg speech, for example, although in theory it is still resounding.

A New Life-Saving Apparatus

When you read a newspaper account of how a pulmotor was rushed to the scene of a smoky fire or gas asphyxiation to revive persons overcome, the chances are that it was not a pulmotor at all. For that life-saving apparatus is being largely replaced by improved oxygen inhalators, the latest of which is pictured above. Known as the "CO_2 inhalator," it supplies oxygen mixed with a small amount of carbon dioxide, the same gas that produces the fizz in soda water. This has the effect of stimulating the lungs of a victim to breathe deeply and take in more oxygen than is supplied by a pulmotor. The inhalator is also used in alcoholic cases.

"Hot Ice"—A New Marvel

"BOILING" an egg by compressing it, and making ice that is as hot as a steaming cup of coffee, are feats announced by Prof. Percy W. Bridgman, of Harvard University, made possible by a machine that exerts a pressure of 600,000 pounds to the square inch.

Besides this pressure, the greatest ever concentrated, the weight of a skyscraper pressing on its foundations seems puny. In Professor Bridgman's machine, hardened steel flows like putty under a force that can be visualized by imagining the entire weight of a passenger train—engine, coaches, and all—supported on the area of a single dime. Such a pressure would raise water in a pipe to a level 260 miles above the earth!

With colossal pressure experimenters are attempting to open new, uncharted fields of research. The lower end of the realm of pressure is already well explored. For example, steel cylinders filled with commercial gases at a pressure of from two to three thousand pounds a square inch are used in the manufacture of synthetic gasoline. And Prof. Georges Claude, versatile French physicist, has discovered that ammonia can be manufactured from the air under a pressure of fifteen thousand pounds to the square inch.

BUT when we venture above these limits startling things begin to happen. The French engineer-chemist, Jean Basset, informs us that he has made diamonds with his recently perfected 300,000-pound-per-square-inch device—simply by pressing them out of charcoal. Of course he may be mistaken, as was his countryman, Henri Moissan, whose crystalline "diamonds" formed by compression in cooling lumps of steel recently were shown to be spinel, a mineral of no great value. Even if Basset really can make diamonds they are likely to prove more expensive than the natural kind. But that does not worry Monsieur Basset, who was just as thrilled when he found that he could squeeze petroleum, long considered incompressible, into a paste thicker than shaving cream.

Now that Prof. Bridgman has produced 600,000-pound pressure, we may expect more wonders. Some, in fact, are already accomplished; such as turning water at 150 degrees F. into "hot ice." However, much as these experiments may lead to commercially, they are yet in the laboratory stage.

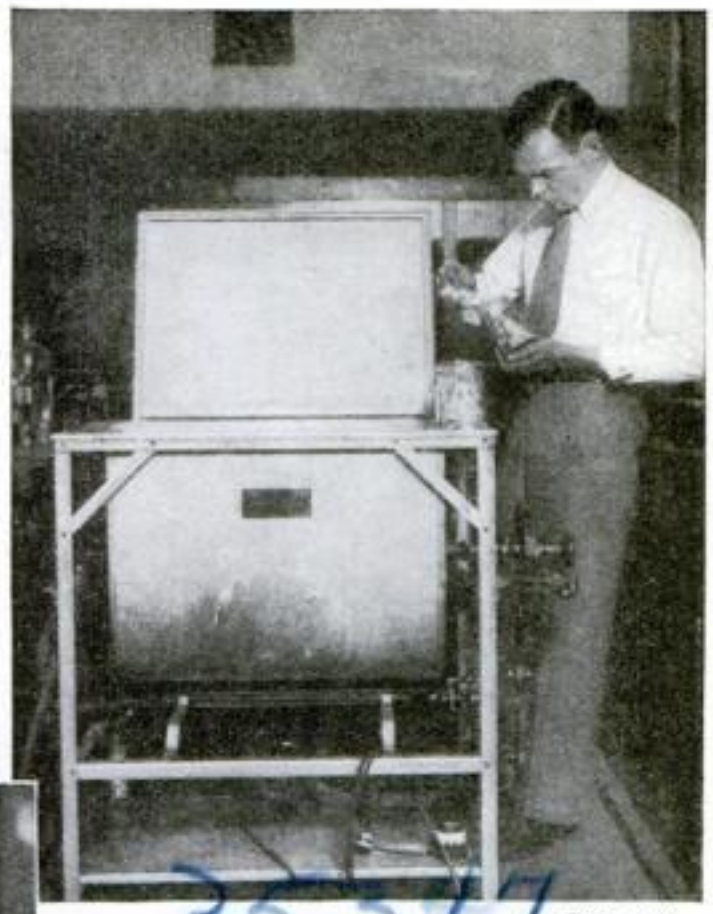
Steam-Heating Outdoors

THE discharge into the East River of the condensation water from nine electric light and power plants in New York City has raised the average temperature of the (Continued on page 165)

Claims Victory over Yellow Fever

From the laboratory of the Charity Hospital, Berlin, Germany, Dr. Max Kuczynski announces that he has discovered the bacillus which causes yellow fever, and has produced a serum that gives immunity. If his claim is substantiated, it will spell triumph in a quest which began thirty years ago with the discovery that mosquitoes were the carriers of yellow fever germs, and which only last year cost the life of Dr. Hideyo Noguchi. Dr. Kuczynski is seen above with assistants.

Dr. Kuczynski studying a cage full of yellow fever mosquitoes. He used monkeys in tests of his serum.



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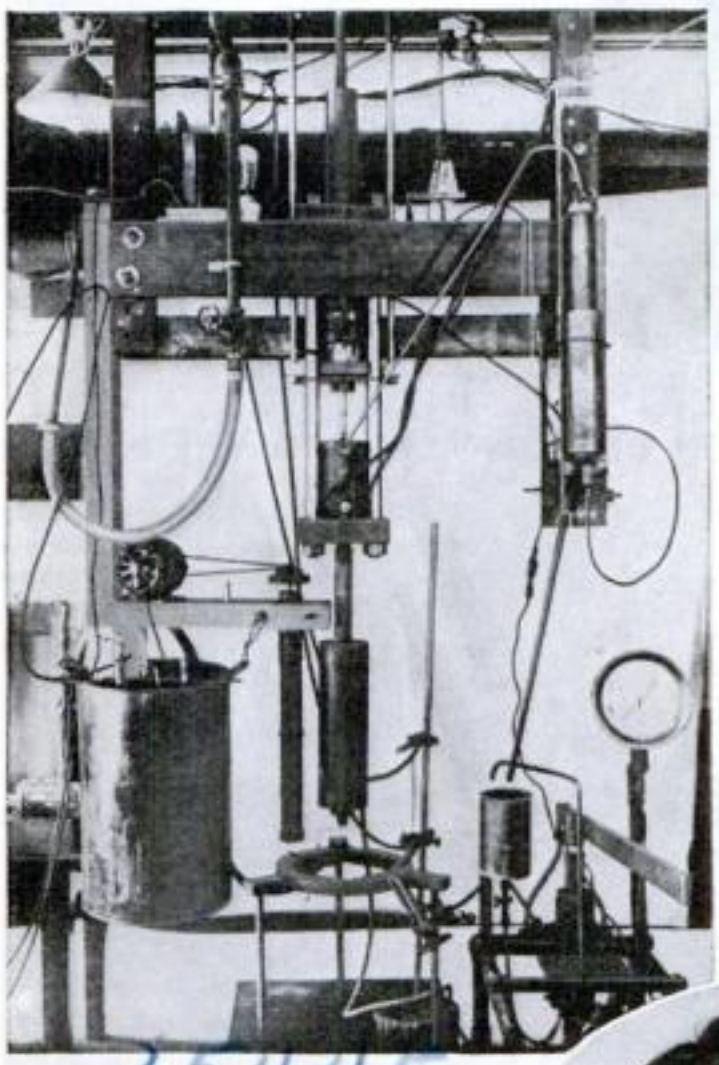
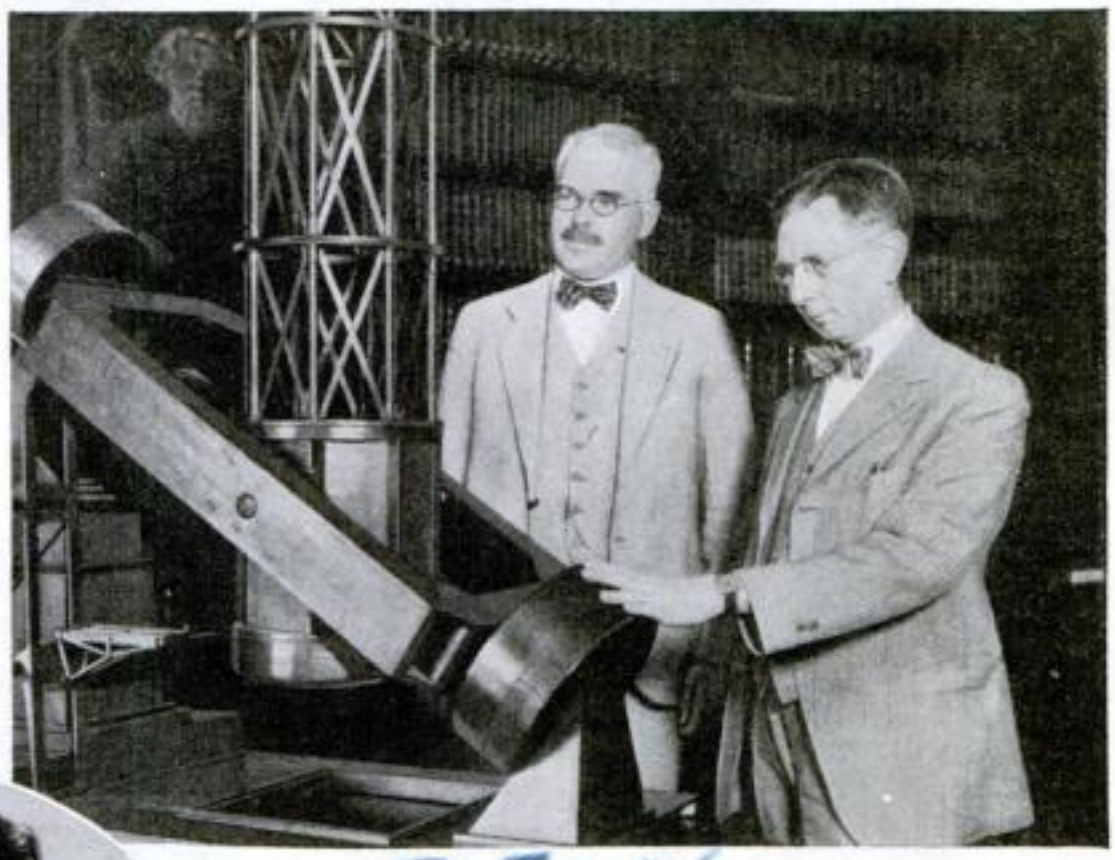
Uncle Sam Runs a Laundry

Washington dispatches the other day brought surprising news that Uncle Sam had started a laundry in the U. S. Bureau of Standards. Back of the project is the purpose of Bureau experts to determine by tests, if possible, why your colored clothes, sent to one laundry, fade badly, while in another they do not. To this end they have devised the special washing machine shown above. It is known as a "launderometer." With it they hope to determine just why clothes fade, and what laundry methods will cause them to fade least. Here pieces of cloth will be subjected to various treatments such as are employed in different laundries, and resistance of the cloth and dyes to fading will be measured. W. C. Smith, who is in charge of the experiments, is seen above with the new machine.



A Magical Machine

Above is the wonderful apparatus with which Prof. Percy W. Bridgman (at the right) has produced the highest pressure ever concentrated—at 600,000 pounds to the square inch. This is equal to the pressure that would be encountered at the bottom of an ocean 250 miles deep. As told on another page, substances are strangely transformed under such crushing force. An air pump is used to raise the pressure. Material to be compressed is placed in a small hole bored in solid steel five inches thick, and stopped up by a small steel plug.



Model of Greatest Telescope Completed

New realms of space will be opened to the view of mankind, and history will be written in the sky, when the projected 200-inch reflector telescope, largest in the world, is first trained on the heavens from an observatory in southern California. Plans for the huge instrument were described recently in POPULAR SCIENCE MONTHLY. As a preliminary to its construction, the California Institute of Technology, Pasadena, has just completed and exhibited a scale model of the new telescope, shown in the photograph above. Examining it are Dr. Francis G. Pease (left), who designed the great 100-inch reflector at the Mount Wilson Observatory, California, and Dr. John A. Anderson, physicist of the same observatory. The new 200-inch reflector is expected to bring our planets much nearer and to reveal millions of new stars and catch the faint glimmer of universes so far away that it will have taken millions of years for their light to reach the earth.

America Hails the Autogiro

With its odd "windmill" flailing the air, the autogiro takes off and lands almost vertically. It can be stopped in fifteen feet after coming to earth.

These photos show the first American flight of an autogiro, revolutionary "windmill plane," of the type which Juan de la Cierva flew across the English Channel. Above: The craft flying straight overhead at Philadelphia, Pa.

Señor de la Cierva's invention uses its "windmill" blades, which swing horizontally, for both lifting power and stability in flight.

Smiling from the cockpit, Harold F. Pitcairn, airplane builder who brought the autogiro from England, piloted it on first flight.

Engineer's Puzzles Prove Abilities of Workers

NINE pieces of wood are used in a remarkable series of tests which show men and women at the General Electric Co., West Lynn, Mass., the work they are best fitted to do. Four thousand persons have assembled these pieces of wood in a jigsaw puzzle to demonstrate their mechanical ability. Those who completed the task in less than three minutes proved successful when they entered engineering, scientific research, or all-around machining. Those taking from four to six minutes failed at jobs requiring mechanical aptitude.

Ability, as measured by the jigsaw puzzle, concerns mechanics alone. It does not give an indication of the candidate's ability in other work. For this purpose other tests have been devised. One, which shows finger dexterity, uses a block with small holes at one end and a pile of pins at the other. The candidate is timed to see how long it takes him to put a pin in each hole.

Executive ability is tested with words, the candidate replying to each with the first word that it suggests. If the words suggested are objective, relating to fact or observation, rather than subjective, relating to personal feeling or attitude, the candidate is considered fitted for executive work requiring disinterested opinions and decisions.

Johnson O'Connor, a designing engineer, devised the tests after six years of experiments. The records show that in an extremely high percentage of cases the tests correctly gaged the ability of applicants and placed them in the positions they were best fitted to fill.

With nine pieces of wood cut into a jigsaw puzzle, Johnson O'Connor has correctly gaged the mechanical ability of 4,000 General Electric Company workers at West Lynn, Mass.

An employe demonstrates finger dexterity by fitting metal pins into a hundred holes.

New Flying Field *for* Roof Tops

Aviation expert invents a tilting platform to halt planes in small space on skyscrapers, steamers, or docks. May revolutionize construction of airports.

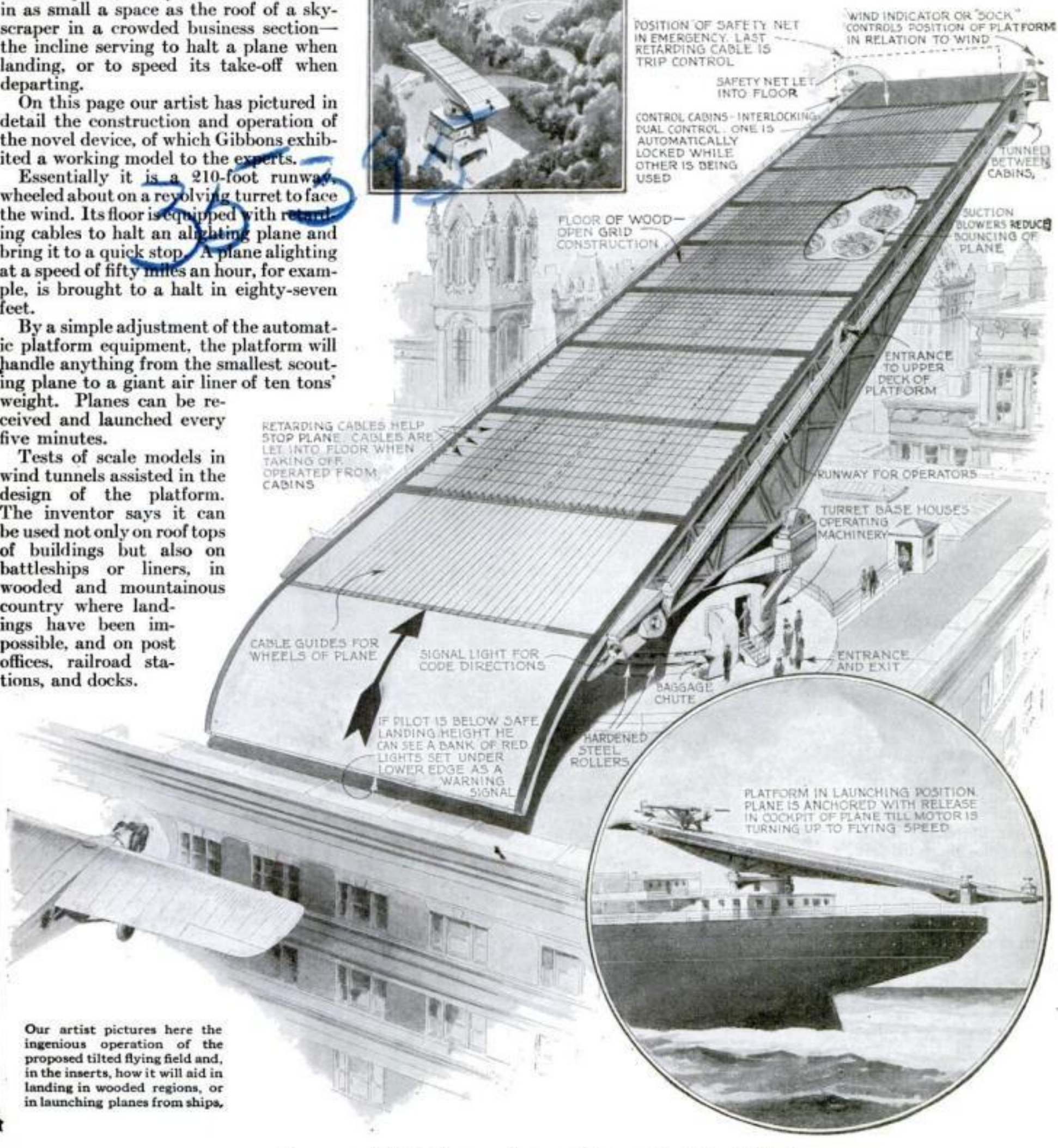
HIGH officials of the U. S. Navy and representatives of the French and English governments recently witnessed a demonstration in Brooklyn, N. Y., of a remarkable new airplane landing and launching device—a tilting platform which, according to its inventor, R. James Gibbons, a member of the advisory board of the Guggenheim School of Aeronautics, New York University, will revolutionize landing fields. It will enable a plane, he says, to land or take off in as small a space as the roof of a skyscraper in a crowded business section—the incline serving to halt a plane when landing, or to speed its take-off when departing.

On this page our artist has pictured in detail the construction and operation of the novel device, of which Gibbons exhibited a working model to the experts.

Essentially it is a 210-foot runway, wheeled about on a revolving turret to face the wind. Its floor is equipped with retarding cables to halt an alighting plane and bring it to a quick stop. A plane alighting at a speed of fifty miles an hour, for example, is brought to a halt in eighty-seven feet.

By a simple adjustment of the automatic platform equipment, the platform will handle anything from the smallest scouting plane to a giant air liner of ten tons' weight. Planes can be received and launched every five minutes.

Tests of scale models in wind tunnels assisted in the design of the platform. The inventor says it can be used not only on roof tops of buildings but also on battleships or liners, in wooded and mountainous country where landings have been impossible, and on post offices, railroad stations, and docks.



Our artist pictures here the ingenious operation of the proposed tilted flying field and, in the inserts, how it will aid in landing in wooded regions, or in launching planes from ships.

Drawn especially for POPULAR SCIENCE MONTHLY *by B. G. Seielstad*

Turning Radio Static into a Weather Prophet

RADIO static has been put to work! The Navy Department in Washington, D.C., is using it as the basis for weather predictions. The apparatus, which Lieut. Eldridge, the officer in charge of the experiments, is seen using in the photograph, records the intensity of static as it comes in on a radio receiver.

The two large loop antennae are swung slowly about, while the apparatus makes a graph of the static and records the direction from which it comes with greatest intensity. The general assumption is that static is caused by electrical disturbance in the atmosphere and that storms may be expected from the direction at which this disturbance is greatest.

Further tests will be made in an attempt to discover the degree of accuracy that might be expected in forecasts made by the new storm-predicting method.

Does the Work of 400 Men

AN ELECTRIC power shovel capable of doing the work of nearly 400 men has been built for stripping earth from a vein of coal at a Missouri mine. The mechanical monster takes bites as large as an average bathroom, swings them 100 feet into the air, and deposits them anywhere within half a block. It is said to be the largest power shovel ever constructed. Operated by electricity and manned by a crew of three, it will remove 400,000 cubic yards of earth a month.

A Rattle 2,400 Years Old

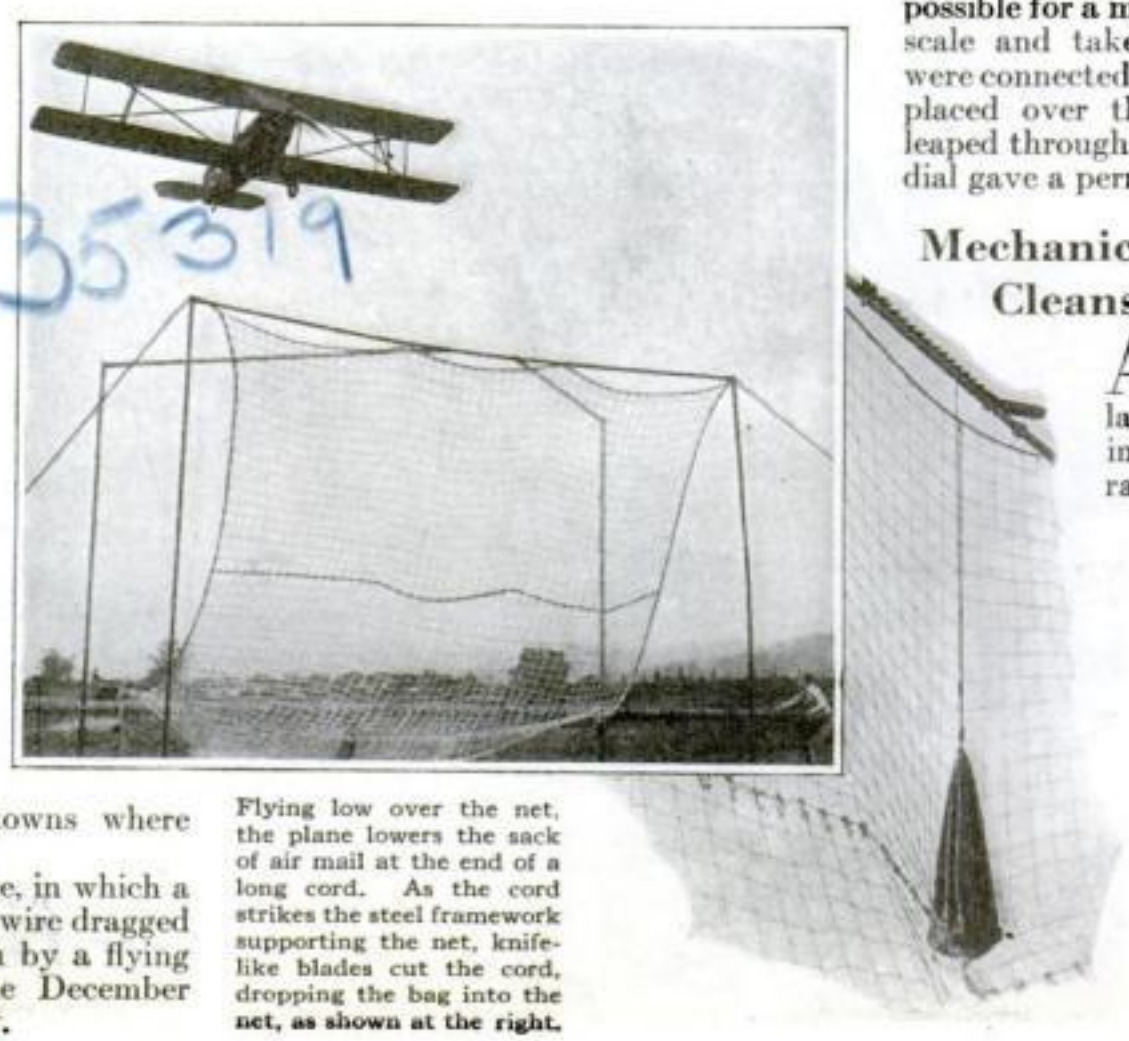
THAT for twenty-four centuries babies have been amused in the same manner was shown recently when the Field Museum-Oxford University expedition to Kish, Mesopotamia, dug up a baby rattle believed to date back to 550 B.C. The rattle, in the shape of a hedgehog, contains a lump of hard mud, which makes the noise when the toy is moved.

Net Catches the Air Mail

NETS to catch bags of air mail have just been tested in Whittier, Calif., by two inventors, M. G. Burcham and Bolton Jones. Without stopping, the plane speeds low over the field, suspending the bag of local mail at the end of a long cord fastened beneath the machine. As the cord strikes a steel framework supporting the net, blades arranged like teeth along the framework shear it off, dropping the bag into the net.

The inventors believe the device will speed up the air mails, and allow deliveries at inaccessible towns where landing is impossible.

A somewhat similar device, in which a sack of mail is attached to a wire dragged into a funnel-shaped trough by a flying plane, was described in the December POPULAR SCIENCE MONTHLY.



Flying low over the net, the plane lowers the sack of air mail at the end of a long cord. As the cord strikes the steel framework supporting the net, knife-like blades cut the cord, dropping the bag into the net, as shown at the right.

Know Your Car

THE hardest trouble to find and the easiest to fix, once you've found it, is a squeak in an automobile. It always is difficult to figure the direction from which such a high pitched noise comes. Finding a rattle is easier, because a rattling noise invariably means perceptible looseness, whereas a squeak is produced only by two unlubricated surfaces rubbing together.

Squeaks and rattles often disappear if the car is left standing in the rain, because wooden parts, such as floor boards, swell. This takes up looseness that is causing the rattle, or forces squeaking parts tightly together, eliminating squeak-producing motion. Water also has some lubricating quality—enough in some cases to decrease friction causing the squeak. But the squeak will promptly return as soon as the water dries out.

Tests Show What It Takes to Make a Car Skid

A BRAWNY motor truck dragged a touring car sideways across a smooth hard-surfaced field near Des Moines, Iowa, not long ago, to find out how much force it takes to make a car skid. This knowledge, as disclosed by the Iowa State College's test, is to aid in the design of banked turns on important through highways.

The pull of the truck was measured by a dynamometer, an instrument resembling a spring scale for weighing, that was inserted as a link in the towing cable. A pointer registered the pounds of force required to drag the car. Since it was impossible for a man to run along beside the scale and take readings, electric wires were connected to it. A sheet of paper was placed over the dial and sparks that leaped through it from the pointer to the dial gave a permanent record.

Mechanical Section Gang Cleans R. R. Ballast

A REMARKABLE machine which replaces a large section crew in cleaning the stone ballast along railroad tracks was tested with success recently by the Pennsylvania Railroad. It propels itself along the rails, picking up the stones, cleaning them, and replacing them as it goes. It is said to have cleaned 1,200 feet of ballast an hour, far in excess of the amount cleaned by the average section crew.

Railroad officials believe the new device will reduce maintenance costs.

How Much Do You Know About Chemistry?

TEST your knowledge with these questions, chosen from hundreds asked by readers. You will find a list of the correct answers on page 136.

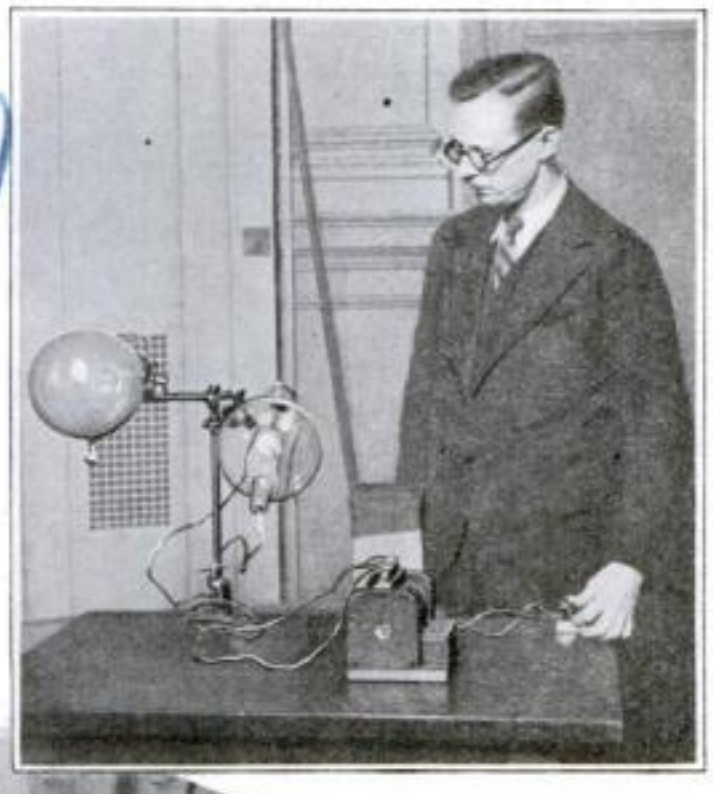
1. What makes things burn?
2. How do clover and other leguminous plants enrich the soil?
3. What simple test will reveal whether cloth is all wool?
4. Why does battery acid "burn" holes in your clothes?
5. How does soap soften hard water?
6. What is marsh gas?
7. What is the difference between steel, cast iron and soft iron?
8. What makes a bad egg smell so disagreeable?
9. How can cotton fabrics be made almost fireproof?
10. How does baking powder work?

Tame Deadly Rays to Make Artificial Rubber

THROUGH a window of high-temperature glass, thinner than the thinnest tissue paper, rays more powerful than those of radium stream at eight tenths the speed of light from a new electric "cathode tube." Six of the powerful new tubes, invented by Dr. C. M. Slack, of the Westinghouse Lamp Company's Bloomfield, N. J., research laboratory, have been sent to laboratories in various parts of America. There they may aid in the discovery of a successful process for making artificial rubber, and in the study of the effects of the rays on animals.

Like the cathode tube perfected by Dr. W. D. Coolidge, of the General Electric Company research laboratories, the new tube miraculously transforms substances with its rays, causing white crystals to glow fiery red, and rabbit hair to turn white. By substituting a glass window for that of metallic nickel film in the Coolidge device, Dr. Slack claims to have reduced its cost and made his tube a more practical research instrument for the average laboratory.

Another type of cathode tube is used in the cathode ray oscillograph, a delicate recording instrument recently employed by Dr. A. L. Atherton and other engineers of the Westinghouse East Pittsburgh laboratory to study the effects of lightning. With this device the effect of each lightning flash is recorded automatically. In the Chilhowee Mountains of Tennessee the engineers, for the first time in history, made a lightning bolt write a complete record of its course.



Two novel types of cathode tubes. Above: Dr. A. L. Atherton with cathode ray oscillograph to study lightning flashes. Left: high-power tube developed by Dr. C. M. Slack.

Traveling Sawmill Made from Old Motor Car

A TRAVELING buzz-saw that cuts lengths of cord wood into short blocks and throws them in a pile, doing the work of six men and requiring the attention of only one, has been constructed from an old motor car by a workman in Portland, Ore. Blocks attached to an endless belt carry the lengths of wood up an incline where three whirling saws, driven by belts from the rear wheel of the automobile, cut them into usable lengths for householders to burn in their stoves. The operation of placing the sticks on the endless belt is the only one required by human labor. After the stacked wood has been cut, the operator drives on to the next job.

"Paint" Cars with Fabric

RAILWAY coaches covered with fabric instead of paint have appeared in England. The Southern Railway is applying long strips of fabric to the exterior of the cars instead of paint as protection against the weather. The new process is said to be speedier than painting.

Wants Science of Matter Termed "Rheology"

A BRAND-NEW scientific term, "Rheology," has been suggested by Dr. E. C. Bingham, chemistry head at Lafayette College, Easton, Pa.

Our knowledge of the movement of electrons is far greater, he says, than our information about the movement of molecules. The former study has been responsible for the science dealing with electricity. The latter, dealing with the flow and deformation of matter, has never been given a name, Dr. Bingham says, and he suggests "Rheology" as the term to include our studies of the plasticity, elasticity, and fluidity of matter.

Earth's Shape Altered by Tides in Its Crust?

THE earth's crust rises and falls under the influence of the moon, just as the water of the ocean swings between high tide and low tide. This is a theory advanced by Dr. Harlan T. Stetson, assistant professor of astronomy at Harvard University. It answers, he says, the puzzling question of why the latitude of a definite point on the globe varies widely when measured from the equator.

If the moon forms tides within the crust of the earth's surface, thus changing its form slightly, Dr. Stetson points out, this accounts for such variations.

Byrd Using Navy Sextant

IN OUR January issue it was stated that the bubble sextant taken on the Byrd Antarctic Expedition was invented by Commander Byrd. This is not correct. Byrd invented a bubble sextant, but the one taken on the expedition was designed by Lieut. Commander Noel Davis, deceased, and Lawrence Radford of the U. S. Navy. POPULAR SCIENCE MONTHLY is glad to make this correction in the interest of accuracy.

Venomous Tarantula Lives as Long as a Horse

AN INSECT that lives as long as a horse is undergoing observation in the laboratory of Prof. William J. Baerg, of the University of Arkansas. It is the tarantula, the horrifying poisonous trap spider of the southwestern states. The female lives to be twenty years old, and probably much older, according to Prof. Baerg. The male dies when it is eleven years old, after the first mating season. During those eleven years the male changes its skin twenty-two times and only after the last change is it distinguishable from the female.

Another peculiarity of these spiders is their ability to withstand long periods of starvation. The tarantula locates its food only by touch and sits at the mouth of its burrow waiting for its dinner to pass in front of it. Consequently, there are often long stretches between meals. In the laboratory, the spiders have shown ability to go without food for about a month.

New Bus Trailer Built to "Ride Like a Plane"

"HIGHWAY flying," intended to give motor transport passengers the smooth, easy sensation of air travel, has been made possible by an "aerocar" trailer, designed by Glenn Curtiss, pioneer American aviator. A pneumatic coupling that attaches the trailer to the motor car is said to absorb road jolts. Its light weight and strong construction permit high speeds.

Passengers enter the streamlined car by a door at its side and have a clear view from several windows in the body. Recently the "aerocar," traveling from Florida to Detroit, Mich., is said to have maintained an average speed of forty-two miles an hour.

Trace Old British Town

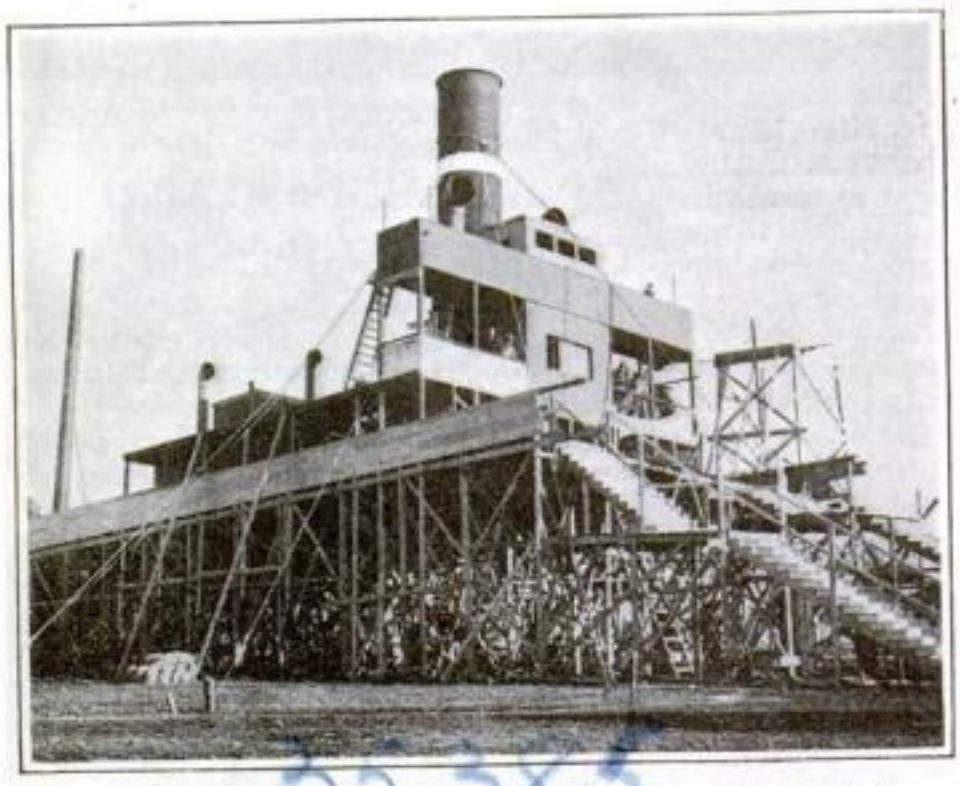
IN A. D. 60, about four years before Rome burned down to the accompaniment of Nero's fiddle, a small town of wooden houses on the site of the present city of London, England, went up in flames. This place was the stronghold of the semilegendary Queen Boadicea, who had led a revolt against the Roman empire two years before the conflagration destroyed her little capital.

Evidences of the ancient fire are believed by scientists to have been found recently, when excavations around London brought to light a layer of red earth ten to fifteen feet below the present surface of the ground. Investigation showed that red was not the natural color of the clay that was dug up, but that the earth had been burned red, like brick.

Whirling Cylinder Drives Odd "Flying Worm"

A HUMMING bird's flight is said to have suggested the idea of a strange aircraft now under construction in San Diego, Calif., to its inventor, Paul Maiwurm. Because it is designed to be driven by a curious propelling cylinder above the fuselage, replacing the usual bladed propeller, the machine has been dubbed "The Flying Worm." This cylinder, formed of steel tubes and about six feet in diameter, is driven by the plane's eighty-horsepower air-cooled motor. Spiral fins on the outside and inside of the cylinder are expected to produce the same results as propeller blades, moving the ship forward. Rising and descending are taken care of by tilting the cylinder up or down.

The inventor says he has flown ten small models of the machine successfully. He believes that with the fuselage hanging below the cylinder, the whole resembling an airship with the gas bag open at both ends, the result will be a pendulum effect providing automatic stability.



Make-Believe Liner Built on Land for Movies

TO FORM the setting for an English movie, a huge imitation steamship recently was erected in a field near Elstree, just north of London. The high funnel and bridge of the make-believe craft towered above the level field, and the smooth boarded sides created the impression of a real hull.

To make the picture more realistic, thousands of gallons of water, stored in great tanks, were flooded over the deck in waves to create a "storm at sea" scene. After making "shots" on board the ship for three nights, the costly setting was dismantled.

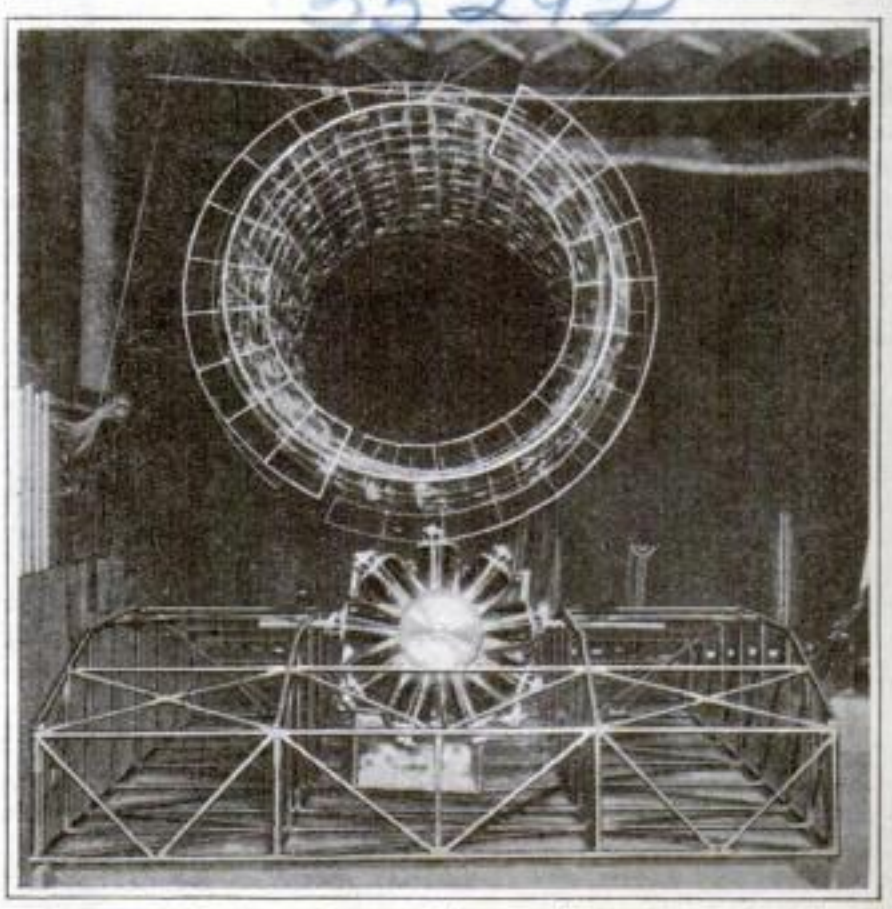
Fishing with Stovepipe

A PIECE of stovepipe tells Norwegian fishermen where to fish! At one end of a length of pipe, a piece of glass is held in place with a water-tight joint of adhesive tape to form a "water telescope." When the end containing the glass is thrust just below the waves and ripples at the surface, the men say they can see fish at a considerable depth below. The black color of the pipe reduces reflection, increasing the effectiveness of the device.

Dental Metals Standardized

AS A result of a recent investigation by the U. S. Bureau of Standards, dentists can select the material for their bridgework and fillings much in the same way that an engineer selects steel and other metal for building a bridge or a skyscraper. He can base his selection upon the known performance of the different alloys.

The properties of dental gold and alloys were studied and the manner in which each reacts under different conditions were recorded. Thus, the dentist can make his choice of alloys to suit individual demands.



Framework for the curious new flying machine under construction, showing rotating cylinder designed to replace blade propellers.

Old Barracks Wrecked by Tanks in War Game

CHURNING splintered timbers into the ground, a fleet of "baby tanks" plowed back and forth through a row of abandoned barracks at Fort Lewis, near Tacoma, Washington, recently in a demonstration of their power. Like angry iron elephants, with lowered heads they charged the buildings, pushing through one side and smashing out the other in a cloud of smoke from the exhausts of the motors which drove the powerful treads.

A barbed wire entanglement, erected beside the buildings to make the feat more difficult, disappeared under the roaring tanks as though it had been made of toothpicks and string. When the war machines finally came to a stop and their grinning crews dismounted, the old buildings had been demolished.

Brig. Gen. M. J. Lenihan, in charge of the fort, took this unique means of wrecking the unused structures as a test for the new tanks and training for the men whose job it is to operate them.

They Fastened on Buttons Centuries Ago

UNTIL a few weeks ago, it was generally accepted in antiquarian circles that buttons as fasteners for garments made their first appearance in the fifteenth century. Then an American woman archeologist, Miss Kate McK. Elderkin, of Princeton, N. J., advanced a theory that buttons were used by the ancient Greeks and Romans.

A thorough survey of Greek and Roman works of art in the museums of Europe showed Miss Elderkin that buttons were found on the armor of the warriors and the tunics of the women.

Throughout the ages, buttons have been made of a wide variety of materials, including ivory and horn, gold and silver, brass and iron, bone and mother of pearl, glass, wood, celluloid, and many others.

But the latest is a chemical compound, a plastic albumen, which experts consider just the thing the button industry has been waiting for. This stuff, from which German chemical wizards predict most of our clothing will be manufactured in the not far distant future, is said to be stronger and faster in color than the vegetable ivory from which most of the buttons that we wear today are made.

Trick Movie Camera Takes Panorama of Card Game

WHO cheated? One after the other, the expressions on the faces of six poker players sitting around a card table in a recent motion picture production appear on the screen for the audience to scrutinize. The illustration below shows how this panoramic view of the players was "shot."

Into a wooden block fastened to the center of the round card table was inserted the axle of a merry-go-round that carried the camera slowly about the circle on small rubber-tired wheels. The camera was moved at uniform speed by means of a small motor. As each player was seated an equal distance from the lens, all were in focus. A long wooden arm supported the wires furnishing current to the motor.

A view of the ingenious movie camera from above, showing how it sweeps in a circle, photographing all the faces around the table.

U. S. Has 6,643 Bridges

IF YOU counted a bridge a minute it would take you nearly five days, counting day and night, to number those spanning navigable waters in the United States. A report of the National Rivers and Harbors Congress gives the number as 6,643. This includes only bridges that cross rivers and bays serving as waterways for navigation. Of the number, 2,337 are railway bridges. The remainder are highway spans. Sixty-two of the bridges are a hundred feet or more above the surface of the water.

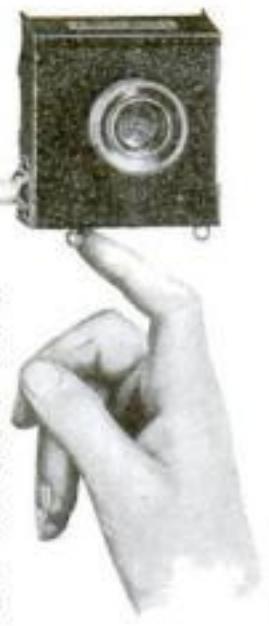
Strange "Mystery House" Looks Like a Village

WHAT is probably America's queerest house stands in the Santa Clara Valley, California. Spread out like a whole village, it has 144 rooms, no twelve on the same level, connected by miles of rambling passageways and corridors. The house was built by a woman of unlimited wealth who believed, so the story goes, that as long as she kept adding to it she would not die. So, for thirty-eight years, carpenters were kept busy increasing the maze of wings and turrets of the rambling structure.

Its interior suggests a setting for a mystery thriller. There are entrances walled up behind, closet doors opening upon blank walls, trapdoors and weird steps of only two-and-a-half-inch treads, and balconies over stairs with no entrance to them. Some of the rooms contain elaborate gold plate and silver fixtures and stained glass windows valued at $5,000 apiece. The apparently separate structures seen in the photograph above all are part of the one house.

Dashboard Cigarette Case Supplies a Light, Too

TWENTY cigarettes can be placed in a compact dashboard case, with an electric lighter attached, which has been designed for motorists who want to have their "smokes" handy when driving. The device fastens by means of a single bolt and one wire attached to the back of the ammeter.



A lid at the top of the case lifts to admit the cigarettes. When a lever at the bottom of the case is moved, as in the illustration, a cigarette slides out an opening in the side and another drops into its place in the case. The lighter head is pushed in to establish electrical contact when a light is desired. The device, its maker points out, saves crushing cigarettes in the pocket when driving.

Bird Fertilizer Producers Protected by Law

SHIP masters carelessly blowing their foghorns, disturbing the guano birds nesting on the islands off the coast of Peru, are punished with a fine; and if it is discovered that their vessels approached within two miles of the islands, their boats are confiscated!

This new law was passed by the Peruvian government in a drastic campaign to protect the birds, which, as described in a recent issue of POPULAR SCIENCE MONTHLY, produce large quantities of guano, an excellent fertilizer. While guano is found in various places, the most valuable variety—containing from thirteen to fourteen percent nitrogen and a like proportion of phosphoric acid—is exported from the Chincha and other islands near the Peruvian coast. These islands produce $1,000,000 worth of the fertilizer a year.

Studying Mystery Disease, Doctor Is Stricken

MALTA fever, the mysterious "undulant" disease which has puzzled medical men, recently claimed a new victim when Dr. Edward Francis, of the U. S. Public Health Service, was stricken with the fever. As was reported in a recent issue of POPULAR SCIENCE MONTHLY, the gold medal of the American Medical Association was awarded to Dr. Francis for his isolation of the germ that causes tularemia, or rabbit fever.

Doctor Francis has been devoting his time for several months to studying the new mystery disease and recently announced that he had discovered that cows have Malta fever and pass it on to humans through raw, unpasteurized milk. Although the disease is rarely fatal, it requires from three to five years to run its course. After the patient is apparently well, he is stricken again. These recurring waves of illness, lasting from two to three weeks, have given the sickness its common name of "undulant" fever. It is believed Dr. Francis contracted the fever from cultures with which he was experimenting in the laboratories of the Public Health Service, in Washington, D. C.

Headlight Glare Reduced by Two New Devices

TO REDUCE eyestrain and nervous tension during night driving, a combination antiglare device has been invented for the use of motorists. An adjustable arm moves a sheet of translucent material behind the windshield to kill the glare of an approaching headlight. It can be adjusted to suit the height and position of the driver.

Over the bulbs in the headlights of the machine are clamped colored deflectors to soften the illumination coming from the upper half of the lights, which most frequently shines in the eyes of approaching drivers. The rays from the lower half are said to illuminate the road ahead clearly for the driver. This combination, says the maker, protects the motorist from being blinded by the glare of an approaching car's lights and relieves him of the necessity of dimming his own lights when meeting another car.

Above: Deflector clamped over upper half of bulb softens glare. Right: Shield kills glare of approaching headlights.

Armchairs of Rubber

ARMCHAIRS upholstered with rubber were recently exhibited at a "Rubber Fair" held in the Royal Agricultural Hall, London, England. They are guaranteed not to get "lumpy" under continued hard use. Another exhibit was a rubber paving block, which was taken from a street where it had been in use for two years. During that time, 32,000,000 tons of traffic had passed over the block, but it was still in good shape.

Follow These Rules When Giving Baby Sunbath

WHEN giving the baby a sunbath, physicians say, certain rules must be observed to make sure that the process will benefit instead of injure the infant. First of all, the baths must be given regularly. Exposure to the sun must be gradual to prevent sunburn, and mothers should be careful to see that the sun strikes the baby's cheeks and hands, but is kept out of its eyes.

The child should be turned from time to time to expose both cheeks. The rest of the skin should be tanned gradually. This can be done by rolling up the baby's sleeves, taking off its socks, and so on. Beginning with from three to five minutes a day, the period of exposure must be increased by slow stages until the maximum of one hour in the morning and one in the afternoon has been reached. The sunbath should be given in a spot protected from the wind.

Longest Suspension Span Nearing Completion

ONE hundred feet longer than the main span of the Philadelphia-Camden Bridge—the longest suspension span in the world—is the 1,850-foot central span of the new International Bridge, being built across the Detroit River from Detroit to Canada. It will be completed in 1929. However, the bridge across the Hudson at New York City, to be opened soon afterwards, in 1931 or 1932, will have a central span nearly twice as long — 3,500 feet. Plans for an even larger suspension span are said to have been drawn up. It will cross the Narrows, from Brooklyn to Staten Island, New York, and have a total length of 4,500 feet.

Auto License Always Handy With This New "Safe"

WHEN you need your driver's license on the road, it is never at home in the pocket of another suit of clothes, if you carry it in a little safe designed to fasten to the inside of an automobile, shown at the left. The tiny strong box, four by two inches, has a combination lock that requires no key. Each box has an individual combination. The safe is made of brass and heavily nickel-plated, so that it is entirely rustproof. When not installed on the motor car, the device, according to the maker, can be used as a dime bank.

In addition to licenses, a few dollars might be cached in the box for emergency use.

Motorists' strong box holds driver's license and owner's registration card.

Mighty Armored Submarine Built by France

THE *Surcouf*, reported to be the largest, heaviest, and most powerful submarine ever built, has been completed at Cherbourg for the French navy. This *Leviathan* of underwater ships is 400 feet long, nearly as long as a light cruiser, with a displacement of 4,000 tons, exceeding by 360 tons the largest previous submarine, the American "V" boats.

A feature of the new vessel is armor protection for all the vital parts exposed when the boat is running at the surface. This makes it in reality an armored cruiser, able to withstand the shells of light quick-firing guns and to return the fire with its own guns.

Diesel engines in the submarine are expected to drive it through the water at a speed of about twenty-five miles an hour, five miles faster than that of the *Humayta*, the submarine recently built in Italy for the Brazilian government and claimed to be the fastest underwater boat in the world.

The *Surcouf* is divided into watertight compartments and is fitted with the latest safety devices. The submarine is named in honor of Robert Surcouf, a famous French privateersman.

New Automatic Gear Shift Invented

SHIFTING gears as easily as advancing the spark lever is said to have been made possible by an invention recently adopted by a large automobile manufacturing concern in England. A single lever on the steering wheel is moved to one of six positions on a small dial, indicating either reverse, neutral, first, second, third, or fourth gear, and the change takes place automatically when the clutch pedal is depressed and released.

The gears of the automatic shift are of the "always in mesh" type as opposed to the sliding gear, and are operated by a mechanical finger controlled from the lever on the steering wheel.

A machine fitted with the new shift, tested for 50,000 miles, is reported to have required no attention or adjustment. Another was successfully driven in an experimental tour over some of the worst mountain roads in Europe.

To shift gears on this new car, simply move the small lever to the desired speed indicated on dial and step on the clutch pedal.

Four Useful Auto Tools Combined in One

A HAMMER, a socket wrench, a tire iron, and a gasoline measuring stick are combined in a new tool for motorists, pictured at the right. The forged steel handle forms the tire iron for prying off stubborn rims. It is also marked as a scale for measuring gasoline in the tank. One end of the head of the tool forms a hammer and the other end has a hexagon shank for mounting interchangeable sockets to form a wrench to fit nuts of many different sizes.

One Man Controls Traffic in New Vehicular Tube

WITHOUT moving from his chair, an operator in the control tower of the new underwater vehicular tunnel running under an arm of San Francisco Bay between Oakland and Alameda, Calif., can govern the machinery functioning throughout the length of the tube. An array of indicators on the control board before him tells him how this machinery is working and records any adjustment that must be made. Buttons and levers enable him to control traffic through the three-quarter-mile tube, which is capable of accommodating 12,000 automobiles a day.

This tunnel, opened last summer, is the first precast concrete tube ever constructed. How it was built in sections and sunk into place was described some months ago in an article in POPULAR SCIENCE MONTHLY. Each section was 203 feet long and weighed 4,500 tons. They were cast in forms in a dry dock made air-tight with bulkheads, towed by tugs to a position above the spot where they were to rest, and slowly lowered into place. The sections were then joined under water and sealed.

You Simply Drive Up Onto This Jack; No Pumping

AN AUTO jack, designed to raise a car without requiring any pumping or cranking, has been produced by an Omaha, Nebraska, inventor. The device has two parts. One is a lug which is bolted to the rim of the wheel, one for each wheel. When a tire has to be changed, the second or lifting part of the jack is inserted in an opening in the lug. The car then is backed or driven ahead sufficiently to ride up on the jack. This, of course, lifts the wheel from the ground, as shown in the photograph.

Fitting the jack in place is described by the inventor as being as simple as slipping a stove lid lifter into the lid. The jack, of cast iron, is fitted to the inside of the wheel so it does not interfere with the removal of the tire. The car is lowered to the ground by driving off the jack, which then is slipped from the lug opening and stored in the tool compartment for the next time it is needed.

An advantage of the device, according to the inventor, is that it holds the tire rim and prevents the wheel from spinning. Also, the lug is attached so the valve is in a convenient place for tire changing. The device is not adapted for use with wire or disk wheels.

Electric Robot for Autos Says "Home, James"

THE latest improvement in one of the automobiles of European make is an electrical device by means of which the passenger directs the chauffeur without saying a word.

Instead of a speaking tube, the interior of this automobile has a set of buttons which, when pressed, convey signals to the driver on an annunciator installed on the dashboard. Made in the form of a glass-inclosed circle, this annunciator is divided into eight sections, each of which bears one of the following printed orders: Start, stop, quick, slow, left, right, turn around, go home.

By pushing one of eight corresponding buttons inside, the passenger causes a light to appear behind the order which he wishes his chauffeur to carry out.

Novel "Sledmobile" Needs No Hills for Coasting

SHOT forward by a lazy tongs mechanism, an ingenious "sledmobile," recently designed, can be adapted either for winter or summer use. The driver propels the sled by pulling a lever. To this the lazy tongs are connected in such a way that the pull extends them to their full length and drives their sharp-pointed tips into the ice. As the extension rod returns, the point rises slightly so as to avoid dragging along the ice and retarding the sled's momentum.

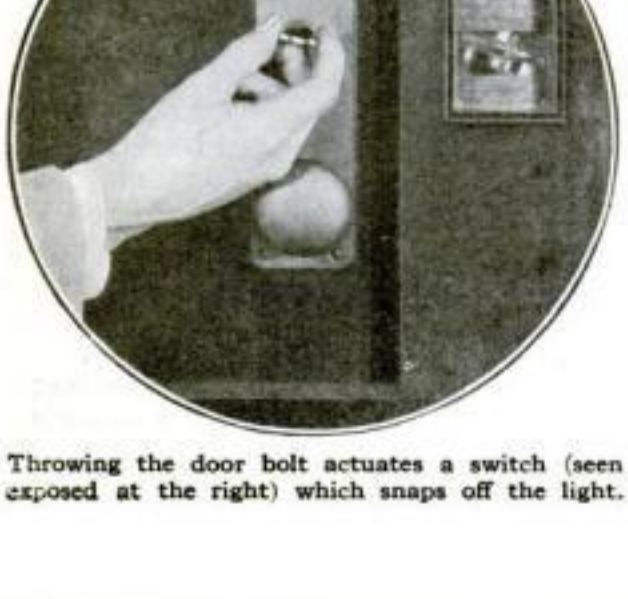
Speeds up to fifteen and twenty miles an hour are said to have been attained with the machine. The device is collapsible, so it can be folded into small size for carrying to a pond or playground.

To convert the sled into a land vehicle, wheels are substituted for the sled runners, and a nonskid material is fitted over the propelling point. Steering is accomplished with the feet.

Door Lock Turns Out the Lights as You Leave

LOCK your door — and all the lights in the room go out! A handy new electric switch built into the door lock is said to be a positive remedy for forgetting to turn off the lights when you leave. It extinguishes them automatically, and later snaps them on again when you unlock the door and reenter. Turning the key in the keyhole does the trick, and saves blundering into furniture hunting for the light switch in the darkness.

The "brains" of the clever contrivance is a little mercury switch, similar to those that control home oil burners. When the lock bolt slides home it tilts the switch so as to break the electric circuit supplying the lamps in the room. The device is particularly designed for hotel rooms and theater dressing rooms. It has been installed recently in hotels of New York City, Chicago, and Cleveland.



Throwing the door bolt actuates a switch (seen exposed at the right) which snaps off the light.

Burning River Mud for Electric Power

ELECTRIC power from "mud pies"! This amazing proposal is actually being tried in Germany with remarkable success, it has recently been reported. The mud on the bottom of a small tributary of the Rhine was discovered to be permeated with combustible matter.

Up to the present, this mud has not only been worthless but has presented a serious obstacle to navigation in the Rhine, into which it is carried. It is now being dredged up, dried into small cakes, and burned to run machinery for generating electric current. The heat value of this strange mud fuel is said to be about two thirds that of anthracite.

Phonograph Needle a Heavyweight

A PRESSURE of fifty thousand pounds—the weight of a fleet of motor trucks—to the square inch bears down upon a phonograph record at the point where the needle touches it, according to H. A. Frederick, of the Bell Telephone Laboratories, New York City. If extended over the whole surface of a twelve-inch record, this crushing pressure would amount to more than 2000 tons.

The weight resting on the needle point, he explains, is only a few ounces, but this point occupies only an exceedingly small space on the record. Thus, if the same amount of pressure is extended over the area of a square inch, the multiplied weight becomes enormous.

A Billion Meteorites Hit the Earth Each Day

A BILLION meteorites, or shooting stars, strike the surface of the earth each day. That, according to Dr. Henry N. Russell, astronomer at Princeton University, is the approximate number of these celestial visitors straying within range of the earth's attraction every twenty-four hours. However, almost all of them are tiny, most of them probably weighing about 1/450,000 of a pound.

The sun, according to Dr. Russell, is bombarded by a constant downpour of these speeding pieces of matter. Sixty tons of them fall into the white-hot crucible of the sun each second.

Gas Lines from Ruhr Will Supply All Germany

A VAST network of steel arteries, with a battery of coke ovens in the Ruhr as the heart, is to stretch over Germany, supplying gas to the cities by pipe line, if a scheme, already partially fulfilled, is realized.

Hitherto, delivery of gas under pressure over long distances has been found impractical because of leakage at the joints of the pipes. A process of welding the pipes overcomes this difficulty. Work has already begun upon the first part of the scheme—laying a horseshoe-shaped main line to include a number of industrial towns as far up the Rhine as Cologne. The next step will be the laying of a line 125 miles to Hanover, at a cost of approximately two million dollars, including gas compressors.

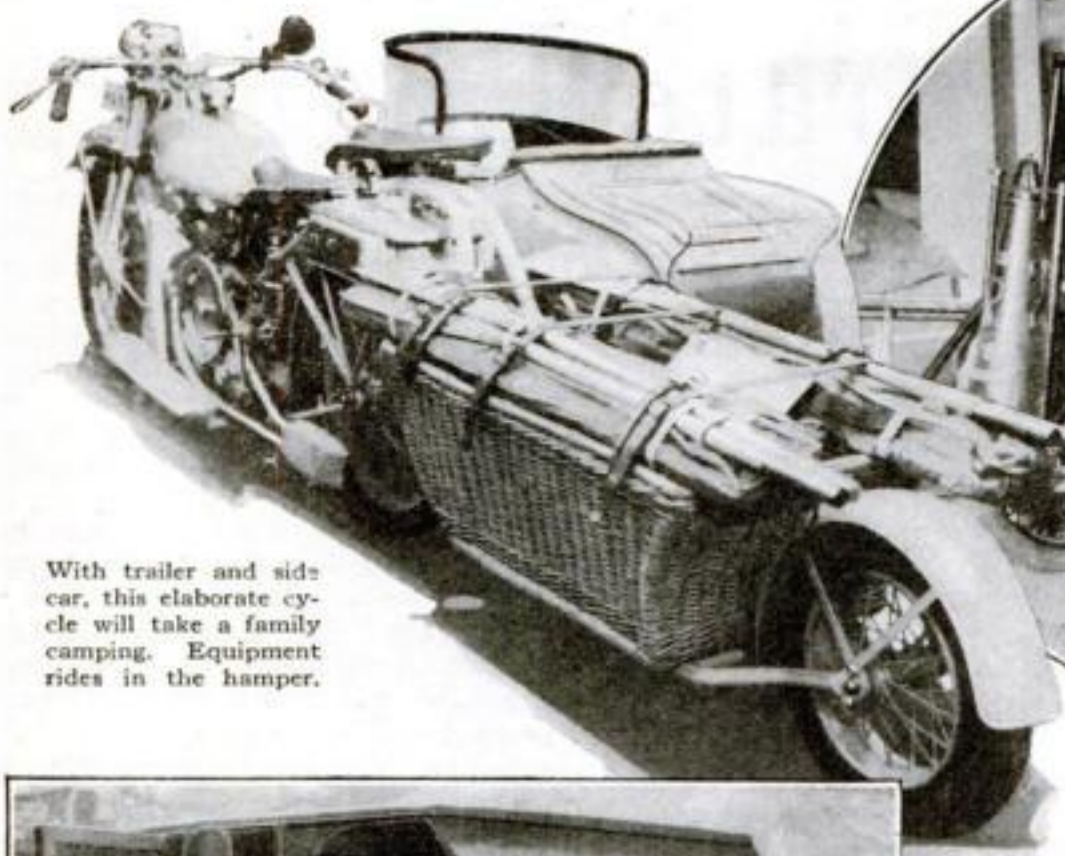
If the Hanover line proves successful, the steel pipes will be pushed out to other large cities of the nation. The operating company will supply gas to the municipality of Hanover for a period of thirty years. The gas is to be made by large coke ovens at the pit heads of the Ruhr coal mines and forced through the pipes under a constant pressure.

This "Steamer" Is 34 Years Old, and Still Going!

A STEAM automobile, built in England thirty-four years ago, when laws were still in force restricting the speed of motor vehicles to four miles an hour, recently drove down a street in Basingstoke, a town west of London. For many years the machine was used in hauling freight and passengers about the town. It was built by the Thornycroft company, which still owns it. The odd vehicle is a front-drive car. The front wheels, almost twice as large as the rear ones, are driven by chains and sprockets. Steering is accomplished by a wheel that turns the rear wheels.

Ordinary wooden truck wheels with iron rims were used and the day of balloon tires and shock absorbers was still a long way off. The funnel from the steam engine that supplied the power projected through the roof of the machine, belching smoke as it moved down the streets.

When the alarm rings, the little two-wheeled fire truck shown at right is hooked quickly to a motorcycle and rushed to the blaze. It carries hose and extinguishers.



With trailer and side car, this elaborate cycle will take a family camping. Equipment rides in the hamper.

Taxi! It rides on only three wheels but it gets there just the same. And the little one-cylinder motor up ahead saves lots of gas.

A beauty parlor on wheels. The inclosed side car contains dressing table, mirrors, and all necessary cosmetics.

35311

The Motorcycle Steps Out as Auto's Rival

SURPRISING improvements in motorcycles, in the way of increased comfort and utility, have been a feature of recent European motor shows. Beauty parlor motorcycles, machines with complete camping equipment attached, motorcycles that carry six people, motorcycles that put out fires—these are some of the novelties that have aroused new interest in this form of motoring.

One beautiful white German machine has a single-wheel trailer which carries a complete camping equipment, including a tent, strapped in a wicker basket. A side car and an additional seat over the rear wheel permit the whole family to get away for week-end trips.

Another German invention is a taxi motorcycle that carries six people. It has three wheels and is powered by a single-cylinder motor mounted over the front wheel. It is designed for taxi service in the country, but may also be used for a touring car by a private family. The machine is said to ride easily, make good speeds, and to be exceptionally economical in operation.

An inclosed side car on an English machine contains all the conveniences to make it a miniature beauty parlor. It even has a dressing table, complete with paneled mirrors. At the recent Olympic exhibition in London was a fire truck trailer which can be attached to or unhooked from a motorcycle in a few seconds. The trailer contains a complete fire fighting equipment for putting out small blazes, including ladders, hose, and hand extinguishers. The motorcycle speeds the equipment to the scene of the fire, where the trailer can be unhooked and backed into narrow spaces by hand.

Remarkable New Glass Can Be Sawed Like Wood

"I WANT plass windows in my house." Instead of suspecting the speaker of an impediment in his speech, future generations may understand that he means a remarkable transparent substance quite unlike the glass now used in dwellings. "Plass," described as a "first cousin to glass," has just been created in the laboratories of the Liverpool University by two English chemists, Prof. E. C. Baly and his son, Edward J. Baly. It is said to have all the outward appearance of ordinary glass, but can be cut or turned like a piece of wood. It is made from a chemical combination that produces a thick syrup, then hardens into the glasslike substance, which is declared to be nonbreakable and noninflammable. It is also believed to admit ultra-violet rays beneficial to health.

"Stay Alive Club" Seeks to Make Streets Safe

A FEW weeks ago, the U. S. Department of Commerce announced that the annual toll of deaths from automobile accidents had increased 243 (from 6,983 to 7,226) in seventy-two American cities.

Shortly afterwards, the "Stay Alive Club of America," an organization devoted to the spreading of the gospel of street safety, was incorporated under the laws of the State of New York.

The principal purpose of the new club is the promotion of careful driving and safe crossing in the city streets. This it means to do by the distribution of literature and other educational methods.

That automobile killings are rapidly on the increase is strikingly illustrated by the fact that the total figure of such deaths in the United States in 1927 was 21,160, as against 18,871 in 1926.

Useful Suggestions for Radio Fans

Secrets of Accurate Logging

How to Adjust Your New Receiver for Hairline Dial Settings—Making Tubes Last Longer—Interference

IN THE early days of radio broadcasting, a list of dial settings for the various stations was not required to be very accurate. It served only as a rough guide in finding stations, because the stations themselves did not stick very closely to their assigned wave lengths.

Now, however, the Radio Commission requires all stations to stay within 500 cycles of their assigned frequency. In the ordinary receiver this means, roughly, within a tenth of a division.

With such accurate transmission, it now is possible to preadjust your set for any given station within a tenth of a division, provided, of course, that you have previously located the correct point. And right here a difficulty arises. With many types of receivers it is almost impossible to read the dial with any great accuracy. The illustration on this page shows where most of the trouble occurs.

It is extremely difficult to manufacture a dial so accurately that it will run absolutely true. For that reason the pointer or indicator usually is placed far enough from the surface on which the figures are printed to avoid chance for friction if the dial does not run dead true.

The result is that for any given setting of the dial, the reading will depend on where your eyes are with relation to the dial. If, for instance, you are in the position of the artist who drew the illustration, the pointer will apparently read directly on the line opposite the figure five. But if your vision were in line with the light rays striking the dial, the reading would be one division lower, or where the shadow of the indicator is shown.

Modern radio receivers tune so sharply that an error of one division on the dial will either eliminate the station or greatly reduce the volume.

There are two ways to remedy the trouble. One is to remember always to hold your head in a certain position when you are setting the dial. That may work out for yourself, but the rest of the members of your family may not be so careful. The other method is to bend the pointer until it just clears the surface of the dial; or, if this cannot be done, then fit an extra thin sheet metal pointer over or under the regular pointer and bend the auxiliary pointer.

With most sets the dial reading depends largely on how you look at it.

Changing Tube Voltages

ON THE side of every box containing a vacuum tube, it is customary to print a table giving the recommended A, B, and C voltages. Many radio fans think that unless this voltage table is rigidly observed, the tube will not function; or, if it does work, its useful life will be very short. This is not strictly true. Changes sometimes are advisable and result in definite advantages.

For instance, the recommended B or plate voltage for the power tube type 171A is 180 volts, and with this plate voltage the recommended C-voltage is 40.5. Applying these voltages to the tube will result in maximum power-handling ability consistent with long life. The B-current drawn from the B-batteries by the tube will be somewhere between fifteen and twenty milliamperes, depending on the individual tube. If you find that you do not require all the power-handling ability of the tube at these voltages, you can effect an economy in battery current by slightly increasing the C-voltage to forty-five; then, with some tubes, you can run the C-voltage up as high as fifty with but little falling off in apparent results. This is particularly true when the audio transformers in the radio receiver do not amplify as well as they should on the low notes.

It also is possible to get more than the maximum rated output from any power tube by increasing both the B- and C-voltages. This may be worth while in an emergency, but of course you pay a penalty in the form of greatly shortened tube life.

The same applies to the filament or A-voltage. If the tube is rated for five volts, it usually will give slightly more power at five and a half volts or slightly less at four and a half. But continuous operation at five and a half volts will cut the life of the tube to a small fraction of normal.

A B C's of Radio

EVERY alternating current transformer consists of an iron core made up of many layers of thin sheets. The core may be square in cross section and square in shape, or it may be built in the form of two squares with a common side. Around the common side, or one side in the case of the plain square, coils of wire are wound. One coil is connected to the supply current, and current is drawn from the other coil.

The coils are insulated from each other and the action is purely electromagnetic. The ratio of the voltage of the current fed into the transformer compared with the voltage of the current which may be drawn from it depends on the number of turns of wire in the two coils. If the secondary coil, for example, has twice as many turns as the primary, the voltage will be doubled.

Trolley Car Interference

ALTHOUGH practically no progress has been made in the matter of getting rid of static interference with radio broadcast reception, many forms of man-made interference can be squelched by the aid of by-pass condensers, radio-frequency choke coils, and so on. This is true of almost any interference caused by the sparking at the brushes of electric motors.

There is, however, one form of man-made interference about which nothing can be done. That is the noise produced in the receiver by the sparks produced by the trolley of an electric car as it rolls or slides along on the overhead wire. If you are so unfortunate as to live close to a trolley line, the only remedy for the interference is to move away. No fancy gadgets, special condensers, or other alleged remedies will accomplish any good.

Cash Prizes for Set Builders

Here's a Fascinating Contest in Which Every Radio Beginner Has a Chance to Win—Just Build and Describe a Simple One-Tube Receiver

Using any materials you please, all parts except vacuum tube and headphones may be your own make.

HERE is a chance to exercise skill and ingenuity in a novel radio contest for cash prizes. If you compete you are sure to gain a better knowledge of radio and of parts used in receivers. And, after you have made parts yourself, you will have a higher opinion of finely built commercial radio apparatus.

The object of this contest is to build a workable one-tube radio receiver by using any of three typical circuits shown on this page, or any other you can devise.

Receivers submitted by contestants will be judged on four points, with each point counting one fourth of the total rating.

The points are: (1) Operation. (2) Number of home-built parts. (3) Simplicity. (4) Cost of construction.

It is strictly up to you what type of receiver you build. You can use all factory-built parts, but such a set could not rate above 75 percent in the contest because it would score zero on point 2, and, probably, relatively low on point 4.

On the other hand, if built of homemade parts, you might get a high rating on points 2 and 4 with, perhaps, a poor mark on point 1 because it is unlikely that home-built parts will equal in electrical efficiency the finished products of radio manufacturers.

The contest is open to everyone, everywhere, without restrictions or qualifications. You need not be a subscriber to POPULAR SCIENCE MONTHLY nor even purchase this copy of the magazine.

The first prize will be $25.00, the second $10.00, and the third $5.00, all in cash. Officials of Popular Science Institute of Standards will be the judges and their decision will be final. In case of a tie, each tying contestant will receive the full prize.

Your entry must consist of a brief description of the set you build, accompanied by a clear, preferably large, picture diagram showing all parts and wires. Number each part and, in describing the receiver, tell briefly how each part was made and the material you used. This is not a contest in literary ability or neat draftsmanship. Your entry is simply to guide the judges in determining which sets are possible prize winners. From these the judges will select receivers which merit actual tests. Builders of these sets will be requested to ship their receivers to the laboratory of Popular Science Institute of Standards by express collect for final judging. All sets thus shipped will be handled carefully and returned promptly after the final judging. However, we cannot be responsible for loss or damage in shipping.

All entries must be received in this office not later than March 15, 1929.

Here are some of the problems you must solve.

First, you must decide on the circuit. Fig. 1 shows the standard three-circuit tickler coil hook-up. Coil *A* usually has from ten to twenty turns of wire wound on the end of the form next to coil *B*. Coil *C* may be from twenty to thirty turns wound on a smaller form and mounted on a shaft so that it can be rotated at the filament end of coil *B*. The number of turns in this coil will depend on the size of wire, diameter of the coil form, and maximum capacity of the variable condenser used to tune it, a problem you must solve yourself.

Fig. 3 is essentially the same as Fig. 1, except that the tickler section of the coil is fixed and its effect controlled by an additional variable condenser. A radio-frequency choke coil is usually, but not always, needed in this type of circuit; and in Fig. 3 the coil is shown connected to the left-hand phone binding post.

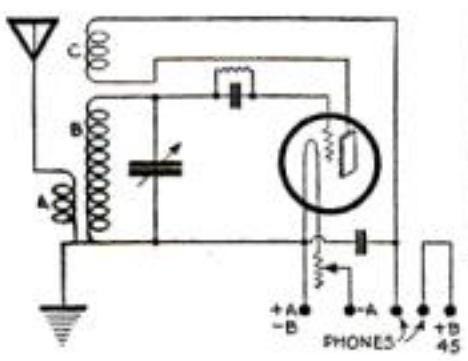
Fig. 2 shows the conventional vario-coupler-variometer hook-up, a tricky circuit to build and operate, but one that may appeal to some because it uses no variable condensers.

YOU are not expected to make the vacuum tube or headphones, as these parts cannot be constructed at home.

While the actual receiver must be produced by your own unaided efforts, there is no rule against obtaining advice or information from any available source. You may ask any friend familiar with radio circuits to help you

This Booklet Will Help You!

IF YOU plan to build, buy, install, or operate radio receiving equipment, send for the twenty-page booklet, "What Radio Buyers Should Know." It will help you, for it includes a list of tested and approved equipment. The price is twenty-five cents. Send your order to Popular Science Institute, 250 Fourth Avenue, New York City.



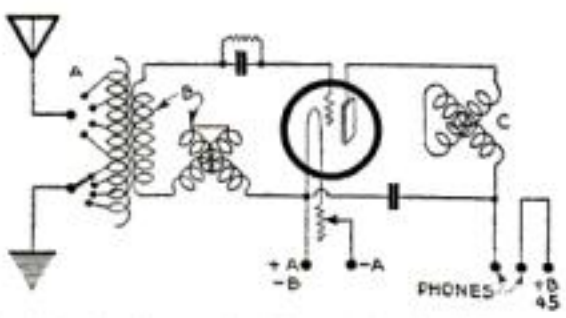


Fig. 1 (top). A standard three-circuit tickler coil hook-up. Fig. 2 (bottom). A vario-coupler-variometer hook-up. You may use these or any other circuit you may wish.

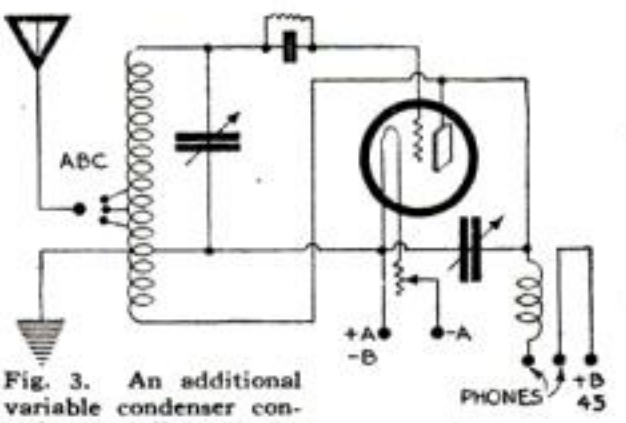


Fig. 3. An additional variable condenser controls the effect of the fixed tickler coil in this type regenerative circuit.

Super-Power for Your Radio

How to construct the mightiest amplifier you could ask for—It magnifies 1,200 times and thunders music of marvelous tones

By

ALFRED P. LANE

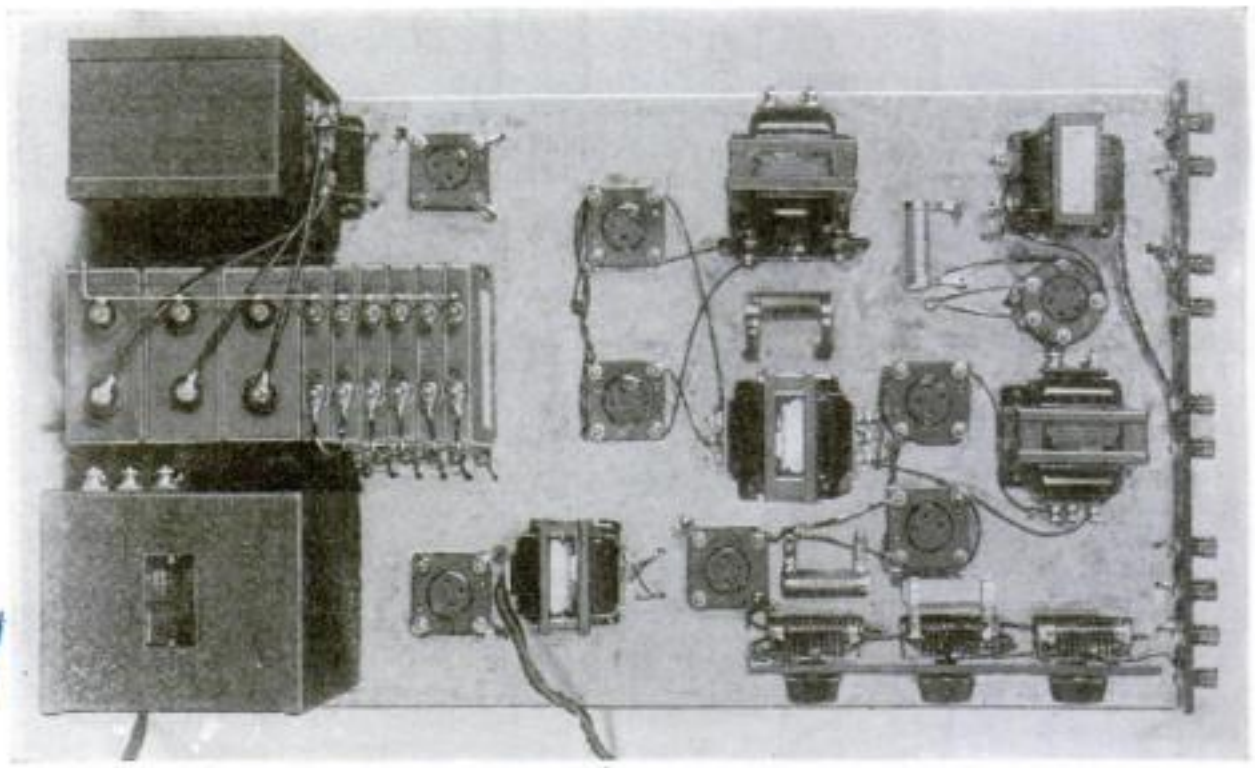


Fig. 1. Our new super-power amplifier as seen from above, showing the layout of parts. Note the squared arrangement of audio transformers. Grid and plate connections are short as possible.

RADIO fans who want the limit in power handling ability, marvelous tone quality, and enormous amplification can have them all by building the super-power audio amplifier to be described here. The arrangement of the apparatus was especially worked out for home construction in the radio laboratory of the Popular Science Institute of Standards.

This amplifier has more power than you are ever likely to need for ordinary home use. It will, in fact, work two modern dynamic cone speakers or up to nine large magnetic cones at full capacity, and so can supply amplified radio or phonograph music for dancing in a large hall. Yet even with this enormous power, the unit will operate at low volume with true tone quality.

The amplifier is arranged to operate a dynamic cone speaker of the 110-volt D. C. type. It supplies the necessary field current and the output transformer is designed to feed directly into the voice or moving coil of the speaker, thus eliminating the step-down transformer fitted in the base of every dynamic speaker. The over-all amplification between input and output terminals is between 1,100 and 1,200 times.

In order to use this amplifier to reproduce phonograph records electrically, just connect the cord from the electrical pick-up device to the binding posts marked "input." For radio amplification connect the *P* input terminal directly to the plate terminal of the detector tube socket and connect the *B* input terminal to the binding post marked "O-90V," which can be set to supply any voltage between these limits.

A careful study of the diagram of Fig. 2 will reveal that the unit consists simply of a high grade B-eliminator circuit which appears above the heavy minus-B and ground line; and a three-stage, transformer-coupled audio amplifier shown below the line. Ordinarily, it is extremely difficult to use more than two stages of transformer-coupled audio amplification without encountering howling due to audio feed-back, but as worked out in this unit, the amplifier is extraordinarily free from such troubles. It is, in fact, more stable than many common two-stage audio amplifiers.

YOU will note from the photograph of the layout at the top of this page that transformers *A3*, *A4*, *A5*, and *A6* are arranged in the form of a square, six and a half inches between centers on a side, and at right angles. With this arrangement, and with all transformer cases grounded to the sheet of aluminum, there is no magnetic or electrostatic coupling to cause trouble.

Readers who want the same enormous amplification to help bring weak, distant signals up to loudspeaker strength, but who do not require the great volume-handling ability of the 250 power tubes, may easily revise the circuit to suit their particular requirements.

Type 171A tubes can be used in place of the 250 tubes, and the entire audio amplifier circuit shown below the minus-B line will require no changes except to use a 1,000-ohm biasing resistance at *R5* and, of course, five volts should be applied to the filaments of the 171A tubes. Above the minus-B line a conventional B-eliminator circuit employing a type BH filamentless rectifier tube can be substituted for the more powerful eliminator circuit shown. Such an arrangement, however, would not supply the necessary current for the dynamic speaker field.

The same kind of high power amplifier with restricted volume output can be constructed for battery operation, if desired. The circuit would be essentially the same as in the amplifier shown below the minus-B line in Fig. 2 except for the filament supply and the C-connections. Type 201A tubes could be used in place of the 227 and two 226 tubes, with 171A tubes in place of the 250 tubes. Parts *R5*, *R6*, *R7*, *C7*, *C8*, and *C9* would not be needed, but you would have to use a separate C-battery for each stage, applying four and a half volts minus-C to the *F* terminal of *A3*, nine volts minus-C to the *F* terminal of *A4*, and minus forty volts to the *F* terminal of *A5*.

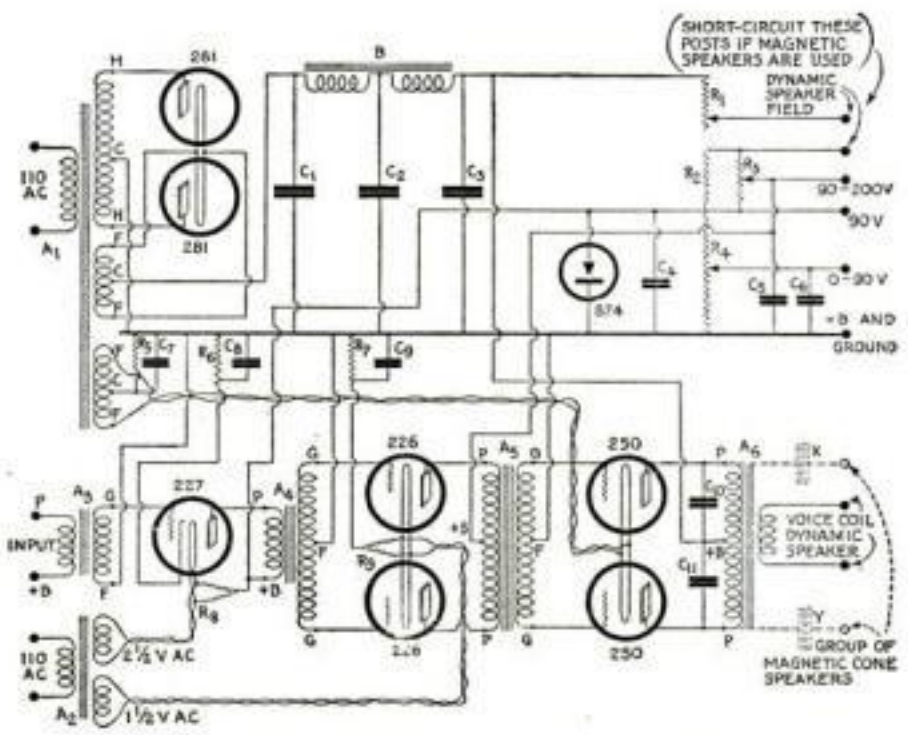


Fig. 2. Technical wiring diagram. Above the heavy minus-B line is the B-eliminator circuit; below is the audio amplifier.

THEN, if you do not require the enormous amplification to help bring in weak, distant stations, but want the greatest possible power handling ability on a dynamic cone speaker, you can easily eliminate one stage of amplification. One way is to consider the *P* and *B* terminals of transformer *A4* as the input terminals, in which case leave out the 227 tube and parts *A3*, *R6*, *R8*, and *C8*. Another way is to connect the *G* terminals of transformer *A4* directly to the *G* terminals of the sockets for the 250 power tubes and leave out the two 226 tubes and parts *A5*, *R7*, *R9* and *C9*.

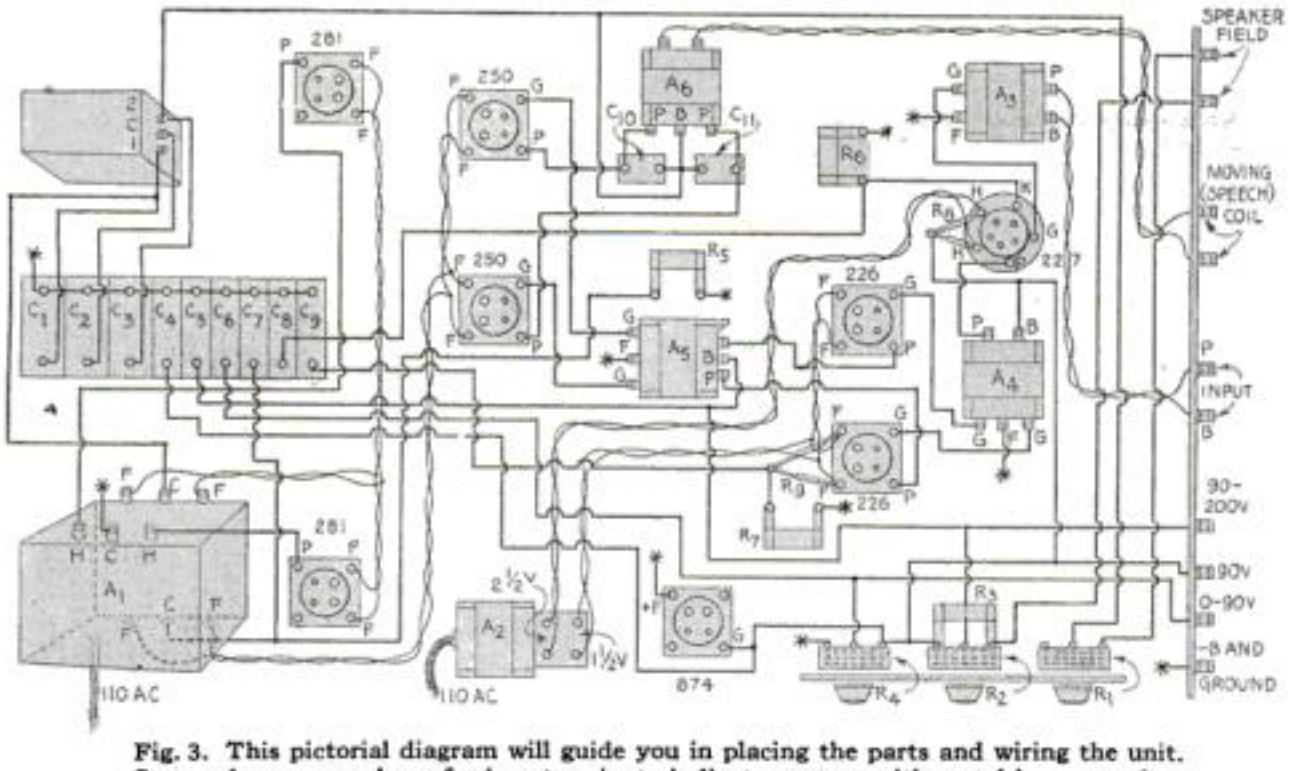


Fig. 3. This pictorial diagram will guide you in placing the parts and wiring the unit. Stars where a number of wires terminate indicate contact with metal base covering.

Another idea, if you want the effect of a two-stage amplifier for normal use, yet desire the additional amplification of the third stage in reserve for emergencies, is to fit an amplification or "gain" control. Leave out the wire connecting the *G* terminal of transformer *A3* with the *G* terminal of the 227 socket. Instead, connect a 500,000-ohm potentiometer between the *G* and *F* terminals of the transformer. Connect the moving arm of the potentiometer to the *G* terminal of the 227 socket. The *F* terminal of the transformer should, of course, remain grounded on the sheet aluminum. By turning the arm of the potentiometer you can get any desired volume, from nothing to the full capacity of the amplifier.

IN CONSIDERING these possible changes in the circuit to adapt it to your own particular requirements, remember that great amplification simply means the ability to take relatively weak electrical impulses and amplify them into very powerful ones, whereas the power handling possibilities of the tubes in the last audio stage will govern the conversion of these amplified electrical impulses into sound energy.

Thus, if 171A tubes are used in the last stage of an amplifier such as the one illustrated, local signals would be amplified to the distortion point very quickly but distant, weak signals would, in many cases, be brought up to satisfactory loudspeaker strength. On the other hand, with the 250 tubes in the last stage, you will be able to shake the stuffing out of the loudspeaker or jar the shingles off the roof without overloading the tubes.

Here are the parts you will need to build the super-power audio amplifier, as shown in the diagrams and illustrations:

A1—Power transformer with one 1,200-volt center-tapped winding 200 milliampere output, and two 7½-volt center-tapped filament windings.

A2—Small filament heating transformer with 1½- and 2½-volt windings.

A3—Audio transformer.

A4—Input push-pull transformer.

A5—Interstage push-pull coupling transformer.

A6—Output push-pull transformer for dynamic speaker.

B—Double choke unit, 150-ohms resistance, 200-milliampere current-carrying capacity.

C1—Filter condenser, 2 mfd., 1,000 volts.

C2 and *C3*—Filter condensers, 4 mfd., 600 volts.

C4—Filter condenser, 4 mfd., 200 volts.

C5, *C6*, *C7*, *C8*, and *C9*—Filter condenser, 1 mfd., 200 volts.

C10 and *C11*—Bypass condenser, .002 mfd.

R1—Adjustable resistance, 4,000 ohms, capacity 79 mils.

R2—Fixed resistance, 4,000 ohms, capacity 79 mils.

R3—Adjustable resistance, 25,000 ohms, capacity 32 mils.

R4—Adjustable resistance, 20,000 ohms, capacity 35 mils.

R5—Fixed resistance, 750 ohms, capacity 182 mils.

R6 and *R7*—Fixed resistance, 2,000 ohms, capacity 112 mils.

R8 and *R9*—Center-tapped fixed resistance, 10 ohms.

Seven type UX vacuum tube sockets.

One type UY socket (for 227 tube).

Ten binding posts.

Strong wooden baseboard, 14½ by 25 inches.

One piece of thin sheet aluminum to cover baseboard.

Insulated wire, bakelite or plywood for mounting binding posts and resistances *R1*, *R2*, *R3*, and *R4*. Screws, etc. Tubes required: one 227; two 226; two 250; two 281; one 874.

Because the unit is heavy, the baseboard must be of substantial construction. It can best be made of ¾-inch boards held together by battens across the bottom. A row of holes should be drilled cross wise in these battens so that you can pass wires back and forth under the baseboard in doing the wiring.

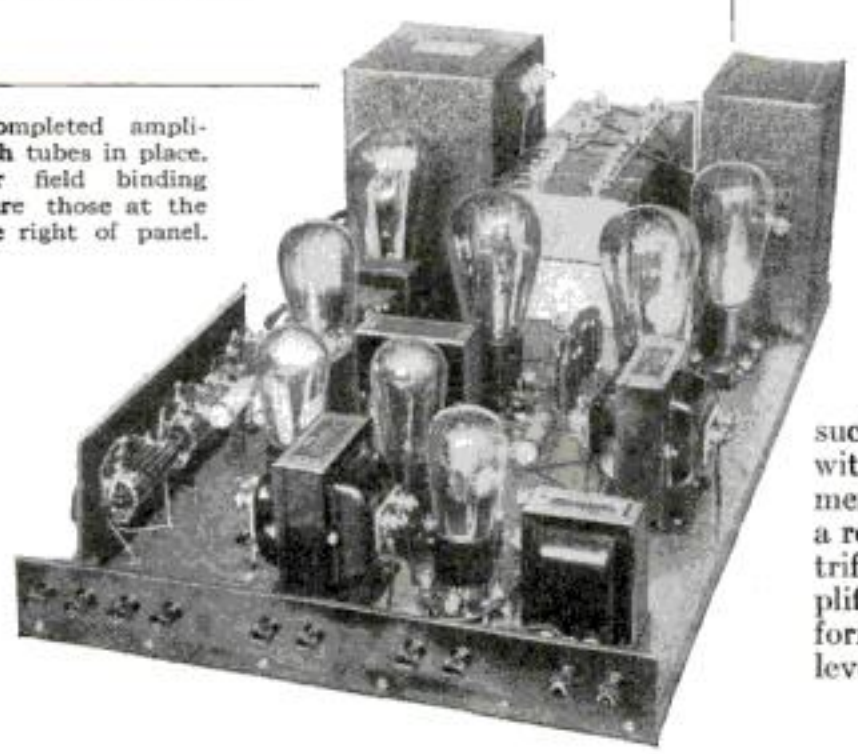
THE thickness of the sheet aluminum is unimportant. The thinner the better, for with thin stock you can punch the holes for the holding screws. This will save drilling. Thin sheet copper or brass can be used, of course, but do not use sheet iron.

The apparatus must be mounted substantially as shown in Fig. 1, the plan view. See that transformers *A3*, *A4*, *A5*, and *A6* are as far as possible from power transformer *A1*. The square formation with the cores set in the positions shown is desirable. You may, however, experiment with other arrangements by connecting the four amplifying transformers with flexible leads so that you can turn them around to determine the positions where the hum is least.

It is impossible to eliminate the hum completely in an audio amplifier of such tremendous power. Even with the most careful arrangement of apparatus there will be a residue of hum which will be a trifle louder than when the amplifier is assembled in two-stage form. However, at the volume level at which this outfit is

(*Continued on page 149*)

THIS super-power audio amplifier has been tested and approved for amateur construction by the Popular Science Institute of Standards. A list of approved parts is available. If you want a copy of this list, or if you wish additional information to help you to build the unit so that it will be best adapted to your own particular requirements, address your letters: Technical Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City.



The completed amplifier with tubes in place. Speaker field binding posts are those at the extreme right of panel.

Furfural, Once Rare, Now Made from Beets

ONCE a chemical curiosity, selling for $30 a pound, furfural, widely used as an insecticide, now sells for ten cents a pound as a result of recent discoveries of chemists, who have succeeded in producing it from oat hulls and other waste farm products.

A discovery by Prof. Orland R. Sweeney, chemist at the Iowa State College, has just opened an entirely new source for furfural—sugar beets. After the sugar has been extracted from the beets, the pulp is put through an additional process which extracts the chemical.

Besides serving as an insecticide, furfural is used in making synthetic resins.

Surgeons 5,000 Years Ago, in Scandinavia

A SWEDISH archeologist, Dr. Gustaf Nihlen, recently returned from an exploration trip to the island of Gothland, in the Baltic Sea, announces that there were accomplished surgeons among the Scandinavians 5,000 years ago!

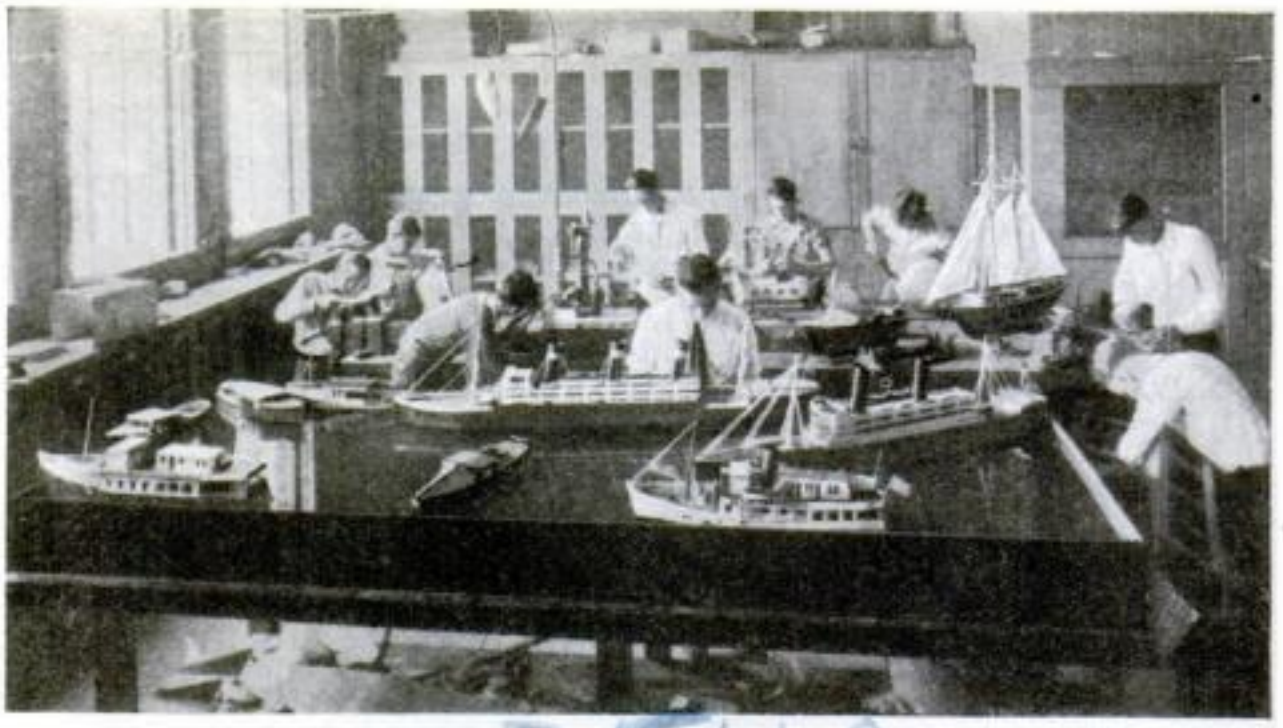
The scientist, while examining human skeletons found in the ruins of a fishing village believed to date from the Stone Age, came upon skulls that bore unmistakable evidence of having undergone the operation known to modern surgery as trepanation—the perforation of the head with a gimletlike crown saw. A stone auger or drill apparently was used by these early practitioners, and the archeologist claims the patients survived.

Long Leash for Telephone Adds to Convenience

WHETHER you like to do your telephoning in bed or sitting in your favorite Morris chair, it is equally easy with the help of a new French invention which allows you to carry your telephone clear across a room if you desire. The device is a spring reel on which is wound a long extension wire connected with the telephone instrument. This can be pulled out to meet the needs of the user. When the telephone call has been completed, a coil spring automatically winds up the wire and, incidentally, guards it from tangling and breakage.

The coil can be hung on the wall, or attached to the floor or a table.

From spring reel on the wall at right, an extension cord unwinds, permitting use of phone anywhere in room.



When School Work Is Fun—Building Ships

FROM ancient galleons to modern passenger liners, the vessels of almost every description are represented in the fleet constructed by boys in the manual training department of the public schools of Long Beach, Calif. A miniature "ocean" in the classroom enables the boys to float their finished craft and adjust the ballast before they take their ships to unprotected bodies of water.

In the picture above model liners and launches are riding side by side in this tank, while the students in the class are busy making additional ship replicas.

Fishing Two Miles Deep!

HOW would you like to reel in two miles of fishline every time you had a bite? An unusual fishing party, led by W. K. Vanderbilt, wealthy New York sportsman, is sailing around the world on the yacht *Ara*, angling for strange specimens that live two miles below the surface of the ocean.

The lines are of fine steel cable which will also be used to lower dynamite to great depths, where it will be exploded to bring deep-water fish to the surface. The trip is expected to last eight months. A large number of glass jars and tanks are being taken on the yacht to hold the strange forms of sea life the party hopes to capture. The elaborate preparation of the craft and its equipment indicate that the voyage will be one of the most ambitious ventures of its kind.

Plane Helps Police Capture Fugitive

SWOOPING from the sky, an aviator helped police capture a fleeing suspect at Clacton, England, a few weeks ago. Two detectives were questioning him near the flying field when he broke away and made a dash for liberty. The officers gave chase. Capt. Edward A. Jones, flying overhead, dove straight at the fugitive, who threw himself flat on the ground to escape the air monster's landing wheels. Meanwhile the detectives caught up and arrested him.

Uncovered plants, in middle, are small compared with those protected by paper.

The Weedless Garden!

PLANTS grow through holes in paper in a strange experimental garden of the Department of Agriculture in Virginia. There are no weeds to hoe. Asphalt paper, covering the ground between rows, smothers them. It also increases the yield of the garden plants and hastens their growth, for the paper, impervious to water, keeps the moisture in the ground and holds the heat of the sun's rays far into the evening.

The benefits of the paper mulch can be seen in the photograph by comparing the size of the plants in the middle row, grown in the usual manner, with those on either side, which have had the benefit of the new method.

This experimental plot produced from two and a half to six times the usual yield and increased the speed of growth of the plants so that two crops were raised in a single season where one had been the limit before.

An Age of Electric Power

AMERICAN manufacturers now use fifty times as much electric power equipment as they did at the beginning of the century. Electric motors installed in factories, reports the National Industrial Conference Board, total more than 26,000,000 horsepower. In 1899 the total was only 492,936 horsepower.

Power Snowplows Keep Alpine Roads Open

ENDLESS tread tractors have invaded the domain of the St. Bernard dogs, driving huge snowplows over the Alpine passes and clearing the roads for winter traffic. The Swiss Postal Department is using a fleet of high-powered machines to keep the frequent snowfalls of winter months from blocking the highways between various parts of the mountainous country. One of these plows, shooting a white cloud of snow nearly to the tops of the telegraph poles that border the roadway, is shown in the illustration cutting through a comparatively light snowfall. Powerful spotlights are installed on the machine so that the work can proceed at night, when necessary.

Scientist, Near Death, Stays by Meteor Find

THAT brave men of learning are ever willing to sacrifice themselves for new discoveries was again demonstrated the other day, when a lone Russian astronomer was rescued from certain death by starvation and scurvy on the uninhabited Siberian plains.

The astronomer, Prof. Leonide Kulik, accompanied by a party of assistants, traveled last summer to the Yenissey province, in Siberia, where the expedition found a great meteor that had fallen in 1908, destroying a large section of woodland. When the members of his party were taken ill with scurvy, the astronomer sent all of them home to Russia, remaining behind alone to complete his scientific observations.

Months passed and nothing was heard from Professor Kulik. Finally a rescue party was hurriedly sent out, and the scientist was found, seriously ill and in an emaciated condition, and rescued.

Giant Ape Skeleton Added to Collection for Study

A HUGE ape skeleton that makes the bones of a large man look like those of a pygmy was one of four recently brought to the United States for addition to the famous collection at Johns Hopkins University, Baltimore, Md.

The skeleton, thought to be the largest of its kind in the United States, is that of an animal weighing 400 pounds and having a height of six feet. It will be examined by Dr. Adolph H. Schultz, professor of physical anthropology at the University, who will measure the size of the various parts, including the skull and brain cavity, for comparison with similar measurements of a human skeleton.

Folding Umbrella Carried in Woman's Hand Bag

WHEN collapsed, the miniature umbrella shown below is little longer than your hand, and fits in a hand bag. When it is open, it is nearly as large as an ordinary umbrella. At the approach of a storm, the silk cover, which protects the umbrella when it is in the hand bag, can be slipped off, the handle telescoped out, and the umbrella opened. When the rain is over, pressure on two springs at the top of the stick closes the umorella and pressing two buttons telescopes the handle, so that it all fits in the hand bag.

Above: The umbrella is unfolded in a jiffy, providing ample protection against rain.

At right: The telescoped umbrella takes up little space in a hand bag, and it is not likely to be left behind when shopping.

New Yorkers Talk Over 8,000,000 Miles of Wire

A SOLID band of copper fifty-six feet wide could be stretched from coast to coast across the United States if the telephone wires used in New York City were placed side by side, allowing an average thickness of a quarter of an inch for each wire. The human voice travels over 8,000,000 miles of copper wire in that city alone, the New York Telephone Company reports.

During the first nine months of 1928, the company added 386,000 miles of wire to its system—enough to reach to the moon and nearly halfway back again! The calls, on an average day, pour into the various exchanges at the rate of ninety a second, making a total of 7,757,511 for the day. This is said to be ten percent of the total number of calls made in the entire country in a day. There are 1,678,664 telephones in New York, not including private lines.

20-Year Avalanche Warning Saves Villagers' Lives

THAT no loss of life occurred as a result of the recent crash of Monte Arbino, the "moving mountain" in Switzerland, was due directly to warnings issued by scientists, who had watched its changing positions for two decades.

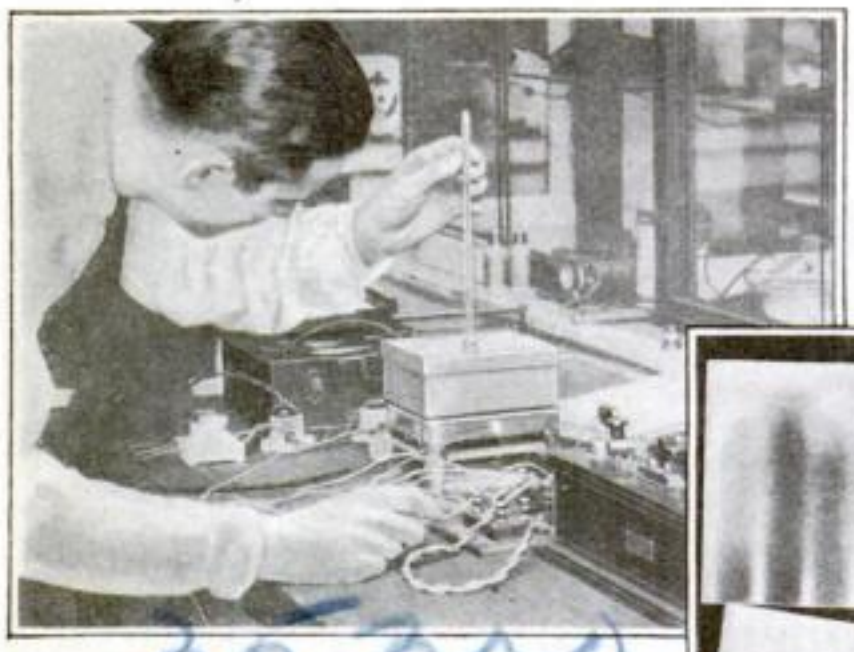
As long ago as 1905, the Swiss Federal Geological Survey predicted the avalanche. Last year, the imminence of the disaster was prophesied by this agency, and several villages were evacuated. Although not a single person was killed or injured, property damage running into the millions was done by the avalanche, which overwhelmed about 6,000 acres of valuable chestnut and fir groves, pasture lands, and forests in the Arbedo Valley not far from Lake Maggiore on the Swiss-Italian frontier.

The mountain had been moving for forty years. The glaciologists of the Federal Geological Survey announced twenty-three years ago that it had proceeded six feet on its disastrous way. When the crash finally came, 30,000,000 cubic yards of rock and debris thundered down the mountainside.

Pine Trees from U. S. in Demand Abroad

AMERICAN pine trees are welcome invaders in many foreign lands. Fifteen countries have asked for information about getting seeds for planting abroad. As nearly as possible, seeds sent in response to such requests have been selected from trees growing under climatic conditions approximating those of the land to which they are going. The U. S. Forest Service is collecting cones and noting at the same time the altitude, geographic location, and conditions of climate under which the parent tree grew.

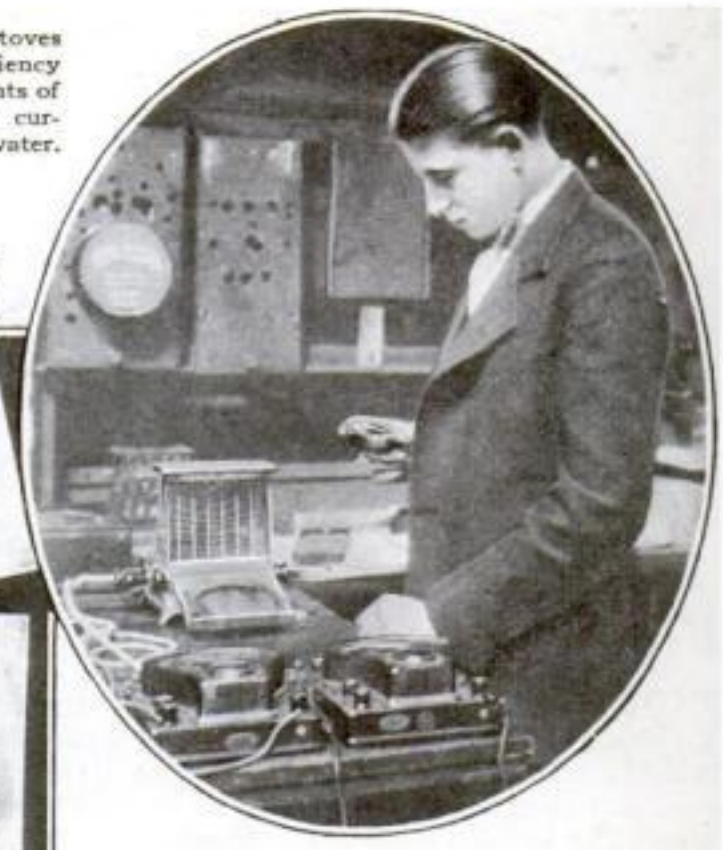
Does Your Wife Burn the Toast? Here's Why



Left: Testing electric table stoves in the laboratory. Their efficiency is determined by measurements of time required and electric current consumed in heating water.

Right: An electric toaster under test to find how evenly it browns bread.

Toasted squares of blotting paper show how poorly inferior toasters distribute the heat.



BLOTTING paper, toasted like bread, recently told engineers at the Electrical Testing Laboratories, New York City, how toast should be made, and what types of electric toasters do the job best.

Little squares of the thick paper were inserted in toasters of various makes and the current was turned on. After a certain length of time the squares were removed. They showed that many cheap toasters burn one end or the center of a piece of bread, instead of bringing the whole to the desired golden brown.

The electrical energy consumed and the time required to produce the toast were also noted in the tests, which were conducted to compare the merits of the different makes and to call attention to the need for standardization. Electric table stoves, irons, and radiant heaters also were included in the tests.

Blotting paper found another use when it showed the distribution of heat on the under surface of different irons in a scorch test.

Earth Supplies Heat for Railway Station

THE heat of the earth is utilized to warm a railroad station at Capa, on the edge of the Black Hills in South Dakota. When a well was sunk to obtain water for the boilers of locomotives that stopped there, hot water gushed from the pipe at the rate of 100 gallons a minute. The water had a temperature of approximately 120 degrees F. An attempt was made to use the water in the boilers, thus giving them a "head start" in making steam. Solid matter in the water, however, made it undesirable for railroad use, so it was run through pipes in the station, where it heats the waiting room satisfactorily for all but the coldest weather.

Seals the Door Against Drafts Automatically

DRAFTS, dust, and rain which enter the cracks under doors are said to be stopped by a simple device that automatically drops to close the crack when the door is shut, and rises to clear the rugs when the door is opened.

The device consists of two parts. One is attached at the bottom of the door with four screws. To this a weather strip is joined by a spring hinge. When the door is closed, a clip projecting from one end of the weather strip presses against the door jamb, forcing the strip downward, against the springs, until its rubber cushion fits snugly against the floor, sealing the crack. When the door is opened, the pressure against the clip is removed and the spring forces the lower section of the device out and up.

Tests have shown, the makers say, that the cost of heating the cold air entering through a quarter-inch crack under a single three-foot door is $2.27 a month, or more than $13.00 for the cold weather season. However, the actual saving may vary, as these tests were taken under average conditions—temperature forty-two and wind eleven miles an hour.

As soon as the door is opened this new weather strip springs up so that it clears rugs or carpets.

Lamps Provide Midnight Sun for Golfers

MIDNIGHT golf has been made possible on a Philadelphia, Pa., course by an extensive system of artificial lighting. Each tee and putting green is illuminated by a 1,500-watt floodlighting unit and the fairways have eighteen projectors mounted on four-foot posts.

Sixteen of these units shed light on the ground, while two twenty-four-inch projectors are tilted so their beams keep the ball visible while it is in the air.

In a recent contest the players reported they could see better by the artificial sunshine than they could by daylight.

Night Planes Flew 15,000 Miles in a Year

GUIDED by airway beacons and compass, night flyers in the United States felt their way through the darkness for 15,000 miles during the last year. This was the average distance flown by planes carrying mail, express, and passengers after dark, the American Air Transport Association reports.

The longest lighted airway in the world is the San Francisco-New York line, 2,680 miles long. Only two night routes are in operation in Europe, the Association says. These are from Berlin to Königsberg, Germany, and from Belgrade, Serbia, to Bucharest, Rumania.

Sweet-Tooth Skunks Raid Hives, Devour Bees

BEES in an Arizona apiary recently were devoured, stingers and all, by polecats with a sweet tooth for honey, the Department of Agriculture reports.

On cold nights, the marauding skunks came to the front of the hives and tapped lightly with their forepaws. The bees, emerging through the small opening that formed the doorway to investigate, were quickly lapped up. The insects, sluggish from the cold, could not act fast enough to fight off the intruders.

"Vest Machine Gun" Pours Bullets into Bandits

WHEN the holdup man commands "Hands up," an ingenious vest machine gun, designed by a Chicagoan, Samuel Schwarz, sends out a fusillade of bullets.

As the arms are raised they pull strings running down the coat sleeves of the wearer to the trigger of an eight-barreled firearm hidden under the coat. It fires its round of shots straight in front toward the highwayman.

The little machine gun is attached to the center of a vest which is strapped over the shoulders and around the waist. This vest also forms a protection against the shots of holdup men, as it is constructed of bullet-proof material.

Appetite of Horned Toad Aids Western Farmers

HORNED toads are not toads at all, and their most valuable attribute is a large appetite for insects. These two statements are part of a recent report of the Biological Survey of the U. S. Department of Agriculture. In reality, says the report, horned toads are lizards, as is shown by their scaly covering. Toads have a smooth, moist skin. Again, horned toads have short tails, while ordinary adult toads have no tails at all.

The bill of fare of these squat, earth-colored lizards consists mainly of insects that are harmful to men, such as the weevil, the chinch bug, the leaf and blister beetle, and destructive caterpillars; they have been known to exterminate a colony of destructive harvester ants. Because of their valuable service to farmers, a movement is on foot to restrict the number of specimens sold to tourists as curios. In some parts of the west, this flourishing horned toad business has already made great inroads on the stock of the region. The states in which they are found comprise the southwestern part of the United States from Missouri to Idaho.

X-Rays "Mix Up" Sexes in Ways Beyond Control

DISCOVERY that X-rays have a powerful effect upon sex characteristics has resulted in numerous experiments on fruit flies, which thereafter produced strange and freakish offspring. Insects which are neither male nor female, but having certain characteristics of both, have been bred in the London laboratory of Prof. James C. Mavor, of Union College.

These genetic changes in living organisms are due to a shifting of the chromosomes by the action of the X-rays. Chromosomes are bits of protoplasm which carry hereditary traits. In human beings this shifting is brought about by natural processes still little understood; the result is that all of us have characteristics of both sexes, both physically and psychologically, combined in different proportions in different individuals.

That these sex characteristics can be controlled by the use of X-rays is beyond present predictions of science. The rays hit the germ cells too indiscriminately. Professor Mavor says that their use for that purpose would be about as valuable as a train-wrecker to a railroad.

Ripeness of Peaches Now Measured by Machine

HOW ripe is a peach? Science is now able to give an exact answer by means of a simple mechanism invented by Prof. M. A. Blake, horticulturist for the New Jersey Agricultural Experiment Station. It measures the number of pounds required to drive a plunger into a peach, thus showing the softness of the fruit's flesh and indicating its degree of ripeness.

When a pressure of from three and a half to five pounds is required, the peaches are ready to be sold for immediate consumption. When the fruit remains on the trees until it tests under three pounds, a considerable loss from bruising during shipment results.

The new invention, taking the guesswork out of thumb and color tests, and showing the growers exactly when picking should begin, is expected by its inventor to result in large savings for them.

By pushing this device into a peach you can tell when the juicy fruit is ripe enough to eat or ship, thus helping growers to market crops.

Coins Rapidly Wrapped by Counting Machine

COINS are rapidly counted and wrapped in packages that allow the first and last coins to remain visible without spilling by a machine recently exhibited in Berlin, Germany.

The coins drop into a slot which admits them one at a time and places them side by side until the number required for a package is reached. Then the machine automatically wraps the pile of coins so each one is held securely, but the end coins can be seen to determine the value of the pieces of money in the wrapper.

The purpose of the machine is to speed up the work of counting and handling money in banks and business houses.

Suggests Martians Fired "Light Bombs" at Us

ARE curious and scientific Martians sending out "luminous bombs" in an attempt to communicate with the earth? Henri Pensa, a French writer, suggests this as a possible solution of a phenomenon observed in southern France.

On three consecutive nights, at exactly ten o'clock, residents in the district of Rodez said they saw something like luminous stars in the sky which broke into showers of sparks. They recalled that a similar recurring display of the same sort was observed on three successive evenings almost exactly a year before, when the light of the "bombs" is said to have been so brilliant that men could be seen walking 200 yards away, although there was no moon.

The repetition of the demonstration at the same time of the year and the identical number of nights leads Pensa to the conclusion that the sight was not merely an ordinary meteoric disturbance, but a possible signal from Mars.

Few Children; Long Life?

DR. J. R. SLONAKER, of Stanford University, claims to have found, by experiments with white rats, that parents with few children live longer than those with large families.

New Danger Lantern Lighted by Battery

FLASHING out a red signal of danger, a new type of electric lantern operating from four standard dry cells has been invented to replace the familiar red kerosene lantern for the use of road builders and contractors. Besides sending an intermittent flash automatically, so that it requires no attention once it is started, the new device is reported to have the added advantage of economy. The batteries will last for two months if the device is used continuously, it is said. Complete with batteries, it weighs about sixteen pounds.

A Record Fishing Season on the Great Lakes

THE Great Lakes last year yielded more fish than ever before recorded in Government annals, the U. S. Department of Commerce reports. The unprecedented catch totaled 81,300,000 pounds! Lake Erie was first, with 23,796,000 pounds, more than a fourth of the total, and valued at $1,831,000. Lake Michigan, yielding 23,680,884 pounds, was at the top of the list so far as value was concerned, for its fish brought $2,354,837. Lake Huron was third, with 15,710,731 pounds, worth $1,414,365; Lake Superior fourth, with 15,301,562 pounds, valued at $918,140; the Minnesota boundary lakes fifth, with 2,139,090 pounds, worth $180,184, and Lake Ontario sixth, with 697,821 pounds, worth $96,081.

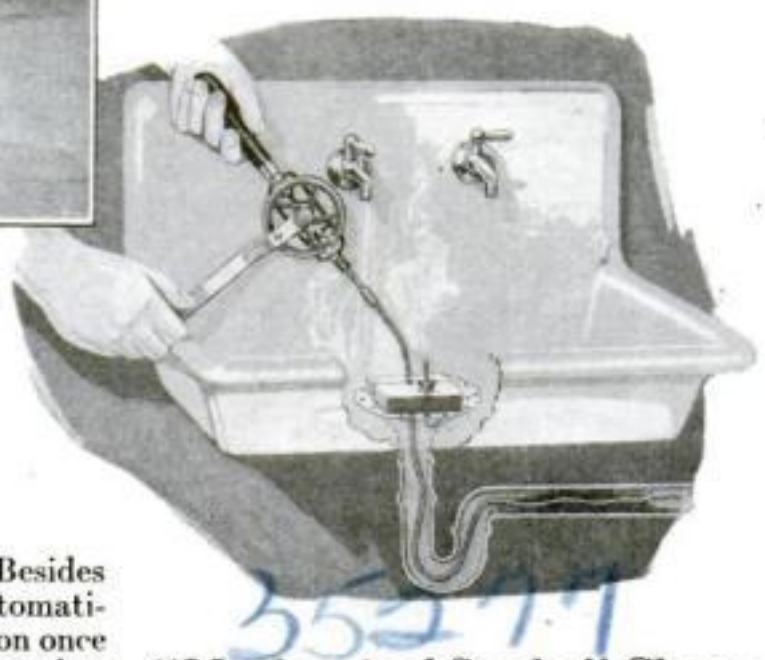
Girl Explorer Hunts for Solomon's Gold Mines

WHENCE came the fabulous wealth that enabled King Solomon, son of David, ruler of Israel and rich in wisdom and wives, to support one of the largest families ever recorded? An English girl archeologist, Miss Gertrude Caton-Thompson, with two companions, started for Southern Rhodesia, South Africa, several weeks ago, to find the answer. The field of the explorer's operations is known as the Zimbabwe ruins, a series of huge, circular walls with fortified gateways, which for years have been described as the remains of gold mines in which King Solomon and the Queen of Sheba had a controlling interest.

Rivetless Ship Launched

A RIVETLESS ship, the first of its kind, was launched the other day at Brooklyn, N. Y. The vessel, an oil tanker, is driven by a 100-horsepower Diesel engine. It is 102 feet long, twenty feet broad, and eight feet deep.

Instead of being riveted, its parts were welded together. During construction, tests made of the vessel demonstrated the dependability of the welded joints.



"Mechanical Snake" Cleans Clogged Drain Pipes

BURROWING into clogged drain pipes, a ten-foot "mechanical snake" recently has been invented to clear stoppages, remove scale from the inside of pipes, and penetrate substances as thick and heavy as putty. It is also said to have the ability to force its way through a passage with many curves. The device, a flexible rotating shaft, is inserted through a block fastened to the outlet of the sink, and is rotated by a hand machine resembling the familiar egg-beater. The whirling motion causes the "snake" to "crawl" through the pipe. When it reaches the obstruction the driving mechanism is alternately spun ahead and reversed until the clogged pipe is cleared.

Women Stick to Jobs Better than Men

WOMEN surpass men in faithfulness to their jobs, according to Dr. Louis D. Hartson, professor of psychology in Oberlin College, Ohio, who traced the careers of 1,000 women and 600 men graduated from that institution from 1914 to 1922.

He found that, of the girls who had remained single, nearly two thirds were still in occupations they entered on leaving college, while half the men had changed jobs from one to six times.

Cotton-Lined Paving Found to Improve Roads

IN ONE of his novels, Honoré de Balzac, the famous French author, introduced a character named Mercadet, a merry swindler, one of whose get-rich-quick schemes consisted in selling stock to believing souls in a nonexisting plant that was supposed to make silk-lined paving blocks to improve the appearance of the streets of Paris.

Little did Balzac, writing this novel, dream that a somewhat similar plan, in a thoroughly practical and honest way, would one day be tried with success! Yet, that happened recently, when a quantity of coarse cotton fabric was embedded in the soil of a 1,500-mile stretch of roadway in Newberry County, South Carolina. The stuff proved to be an effective binder and to act as a waterproof blanket, minimizing erosion and road fractures. The first experiment was so successful that a second stretch has been similarly treated.

Automatic Machine Prints Photos at High Speed

AS MANY as a thousand photographic prints an hour are said to have been turned out by a high speed printing machine invented by LeRoy B. Wall, an attorney of Winston-Salem, N. C. The device, according to its inventor, masks, exposes, and numbers the prints and drops them into a dark box, all with one operation.

Because its automatic operation makes rehandling unnecessary, it is expected to prove a time-saver for commercial printing establishments. It is designed to handle roll or cut film and to take all sizes. The number of prints it turns out in an hour depends upon the size, the larger films being run through the machine at the rate of about five hundred an hour and the smaller ones about a thousand an hour.

The negative is inserted through a door in the front of the machine. As the door is closed, it makes an electric contact which flashes on a light within the machine for the time necessary to expose the print. The exposed prints drop into the dark drawer of the table, from which they are removed from time to time and run through the finishing solution. This drawer, of course, is opened only when the room is dark.

The new high speed printing machine. Closing the door lights a lamp that exposes the print for the correct time. Prints then drop into the drawer.

This Housewife Discovers Kettle Really Sings!

SOME of us remember how our grandmothers would say, "the kettle sings," when the water came to a hissing boil. What, though, would poor grandmother have said and done if her teakettle or stewpot had actually begun to sing "Annie Laurie," or a Schubert song?

This is what a woman in Santa Barbara, Calif., vows happened the other day. Preparing dinner at her electric stove, she was startled to hear the strains of Schubert's "Ave Maria" emanating from a pan filled with simmering beans. There was no radio, phonograph, or similar instrument anywhere in the house.

Being an up-to-date person, the woman did not consult a soothsayer but asked a radio engineer for an explanation. He told her that the bottom of the pan might have acted as a diaphragm and reproduced a radio program which her electric power line picked up inductively, thus carrying an echo of the Schubert Centennial celebration into her kitchen.

Chinese Serve Monkey Brains at Feasts

THE Frenchman's fondness for frogs' legs, and the Chinese liking for soup from birds' nests, seem quite normal compared with an appetite for monkey brains, of which epicureans of Canton, China, are said to be possessed.

This weird dish, travelers say, is considered a great delicacy in that region, where it is served at banquets. And it is liked best when eaten raw!

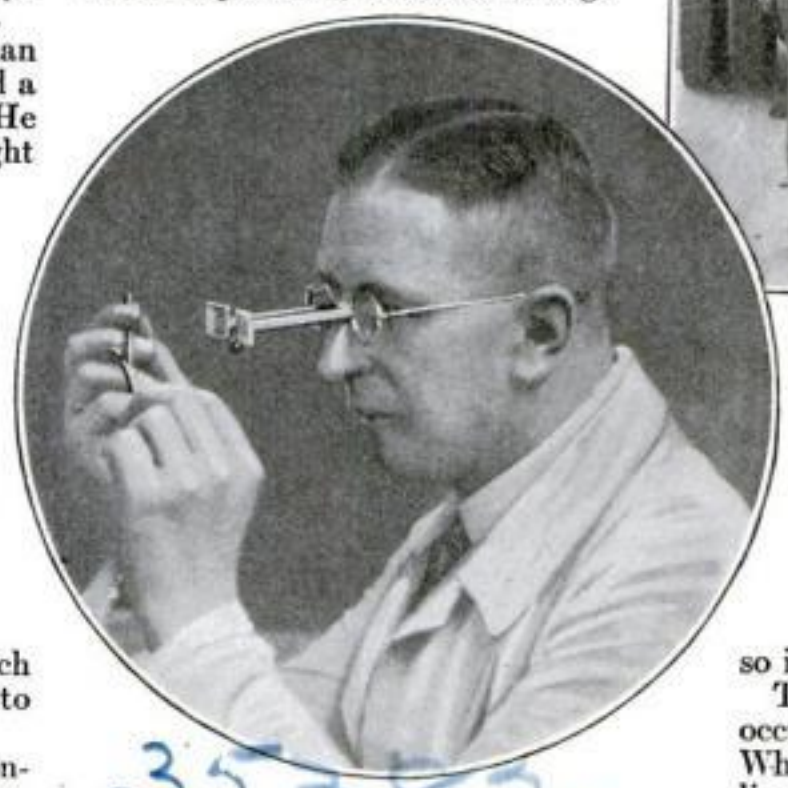
Other Cantonese tidbits are a dish prepared from monkey hands and feet, which high-class restaurants sell at $25 a bowl; python and cobra meat, and fried locusts and pickled water beetles!

Longest Truss Bridge Is Built in Netherlands

THE record for the longest truss bridge in the world is claimed by the Netherlands with the recent completion of a huge structure two miles long across the wide, shallow mouth of the Waal River, connecting the cities of Dordrecht and Moerdijk, in the southeastern part of the country. The bridge is made up of a series of short spans of rigid steel framework, supported by massive piers rising from the river.

Ills from Weather

A SWISS experimenter, Dr. G. Schorer, says he has discovered why weather changes often cause feelings of ill health, especially among old people and invalids. These feelings, he found, are accompanied by excessive negative charges of electricity in the air, while an excess of positive charges of electricity caused a pleasant, refreshed feeling.



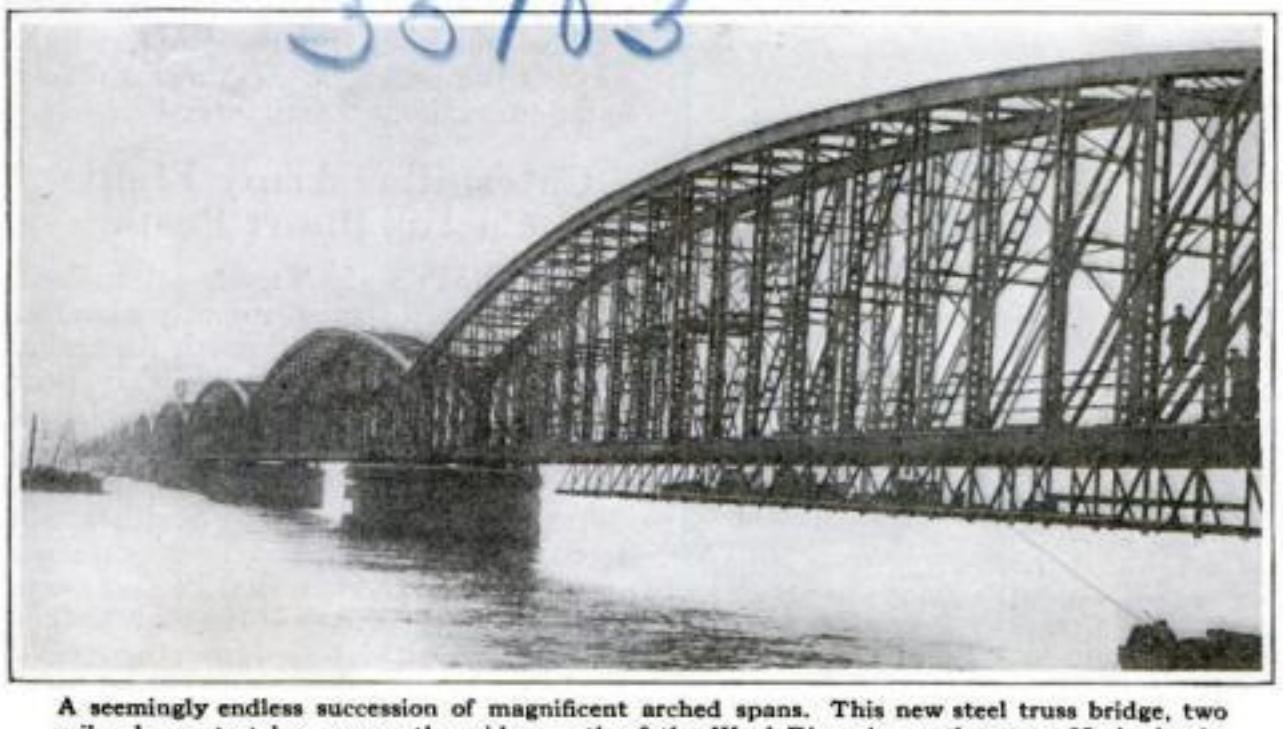
35383

Microscope Lenses to Fit Ordinary Spectacles

IF YOU should look through the lenses of new German spectacles you could see the tiny veins in a fly's wing highly magnified. Specks of dust, scrutinized through the glasses, would appear as big as bread crumbs before your eyes.

These unique microscope spectacles were designed for the use of scientists, doctors, dentists, watchmakers, and jewelers. The magnifying lenses are attached to the frames of ordinary glasses by means of a clip and are held at a distance in front of the eyes. Along the arms of this clip the lenses slide back and forth so the user can focus them to suit his eyes.

35103



A seemingly endless succession of magnificent arched spans. This new steel truss bridge, two miles long, stretches across the wide mouth of the Waal River in southeastern Netherlands.

34261

Coal Delivered Like Food, in Cartons

LIKE soda crackers and cereals, coal is now delivered in paper boxes! A Chicago fuel company decided that the bags in which their delivery men carried the coal into houses spread too much dust, so it adopted a heavy composition box.

The boxes are packed on the truck, occupying all of the space without waste. When the destination is reached, delivery men carry the boxes from the truck with the aid of heavy straps which provide grips, as shown above. The coal is emptied out of the boxes into the coal bin and the empty containers returned to be refilled.

Voices of Famous People Preserved for Future

WOULDN'T you receive an unforgettable thrill if you could hear the Gettysburg Address in Lincoln's voice?

Such an experience science has made possible for future generations. With the coöperation of several phonograph companies, the British Museum is arranging a "gallery of voices," including recorded speeches by King George and Queen Mary, the Prince of Wales, Cardinal Bourne, Lord Kelvin, the late Lord Roberts, the late Sir Herbert Beerbohm Tree, the distinguished actor; Winston Churchill, David Lloyd George, the late Lord Oxford and Asquith, Sir Ernest Shackleton, famous Antarctic explorer; George Bernard Shaw, the great playwright; and other notables whose vocal utterances are almost sure to be of interest to succeeding generations.

Stammerers Not Backward

CHEERFUL news for stammerers is contained in an announcement of Dr. Elizabeth D. McDowell, a speech-defect expert of Columbia University, New York, that the old theory that stutterers are retarded in school is baseless. She examined 7,000 school children and found that stuttering children were in no wise behind those of normal speech.

Boy Flyer Wins $1,000 for Coast-to-Coast Hop

ENTER the prodigy of the air! Not soon, it is believed, will Booth Tarkington, the famous American author, make fun of seventeen-year-olds again. A lad of just that age recently qualified for the aces class by making a solo flight from San Francisco to New York in his own biplane, thereby capturing the $1,000 prize offered by the American Society for the Promotion of Aviation for the first boy under voting age to accomplish that feat.

The youthful aeronaut was Richard E. James, a high school student of Flushing, N. Y. He made the trip by easy stages, accompanied part of the way by Martin Jensen, the California pilot, in his monoplane *Aloha*, the same ship in which Jensen flew to the Hawaiian Islands.

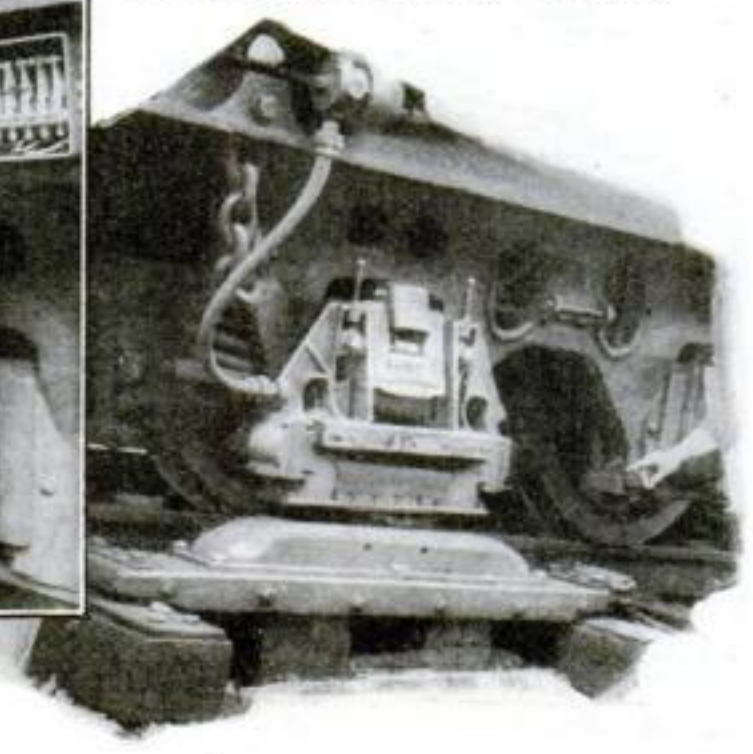
During the long trip, young James had only one mishap, and that a slight one. Landing at Bellefonte, Pa., his plane overturned, but both the enterprising youth and his ship were unharmed.

"Electric Hand" on Brakes Prevents Train Wrecks

AN EQUIVALENT of the "dead man's button" in subways has been applied to speeding passenger trains running between New York and Chicago. If an engineer runs through a signal set against him or is incapacitated at his post, the device automatically sets the brakes and prevents a wreck.

Electric inductors are placed at intervals along the rails and connected with the block signal system. All the locomotives making the run are equipped with receivers attached to the side of the tenders. If the train runs past a signal the receiver, passing above an inductor, picks up an electrical impulse, which by means of relays sets the brakes, at the same time scattering sand along the rails.

After the train has been brought to a sudden stop in this manner, it cannot be started again until a human hand resets the automatic safety device.



Above: The receiver on locomotive tender, which picks up electrical impulses from an inductor along the rails (shown at the right) and applies the brakes to stop the train instantly.

Radio Signal Strength Is Recorded in Colors

EVERY five minutes, an automatic instrument at the Bureau of Standards, at Washington, D. C., tunes-in and records, by means of dots upon a roll of paper, the strength of radio signals from various stations in the country. It is known as the Cambridge thread recorder and keeps a complete record of signal variations which show atmospheric disturbances.

An improved type of the recorder, shown above being tested by E. B. Judson of the Bureau, is equipped with a two-color inked thread arrangement which permits the dots to be made in either black or red. This makes it possible to distinguish between two stations whose signals are being recorded.

A clock, with twelve brass plates taking the place of the hour numbers, governs the instrument. A spring at the end of the minute hand makes an electrical connection as it passes over each piece of brass, setting in motion, every five minutes, the machinery that tunes-in the stations being observed.

The invention includes a radio receiving set of conventional design, and employs two antennae, a high one for reception of trans-Atlantic stations and atmospheric disturbances, and a lower one for reception of near-by stations.

Biblical War Chariot Is Found in Palestine

THE ancient pots in which Canaanite housewives, 3,400 years ago, kept the milk and honey with which the Promised Land was said by the Biblical prophets to be overflowing, have recently been unearthed by the University of Pennsylvania Museum's archeological expedition in Palestine.

Another discovery of the first magnitude was the foundation of a mighty fortress tower, or migdol, adjoining which the scientists came upon the remains of what they believe was the headquarters of the commandant of the fort during the reign of Rameses II of Egypt. They also found a fragment of an ancient chariot, mentioned in the Book of Joshua.

The migdol, the archeologists think, must have been used by the warriors as a last stronghold in case the outer fortress walls were stormed by the enemy. The expedition reported that almost the entire eastern part of the Temple of Mekal, dating from about 1,500 B. C., has now been excavated, and that in its inner sanctuary such treasures came to light as the stone fireplace where the burnt offerings were made, together with pieces of bent bronze wire, charred bones, horns of the sacrificial animals, and other objects throwing new light on the everyday life of the ancient Hebrews and Egyptians.

"Beware of the Dog"—He Carries Hay Fever!

"AVOID goldenrod, ragweed, timothy, corn, and pigweed," used to be the old-fashioned advice given the perennial hay fever sufferer. Alas, his troubles increase as medical science widens the scope of its investigations. The latest anti-hay-fever slogan is, "Beware of the dog!"

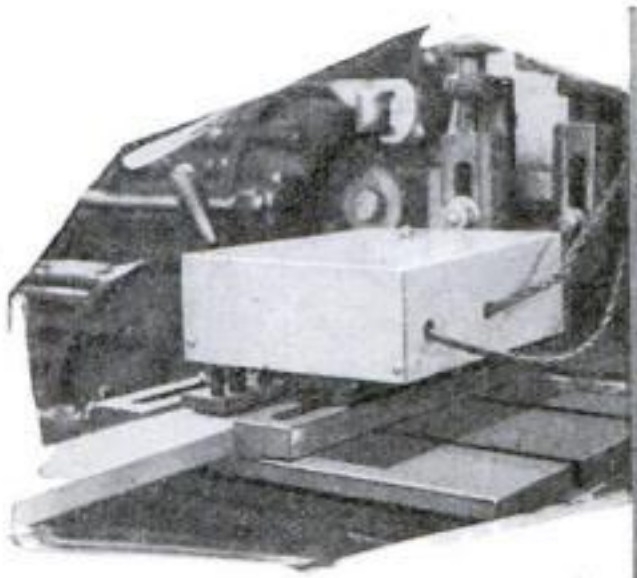
A Maryland physician recently announced that the animal which had generally been considered to be "man's best friend" is a carrier of the various types of flower pollen that cause the troublesome disease, and that horses and cats are guilty of the same offense. And not only in their lifetime, but long after they are dead and gone our four-footed and feathered pets, according to the doctor, may give us "the sniffles," for hay fever may be contracted by touching a horsehair sofa or a feather bed.

The explanation is that the animal's pelts and birds' plumage become thoroughly pollenized by the wind, which spreads the pollen of the various plants and flowers that are hay fever breeders.

Caterpillar Army Fights Cactus Plant Pests

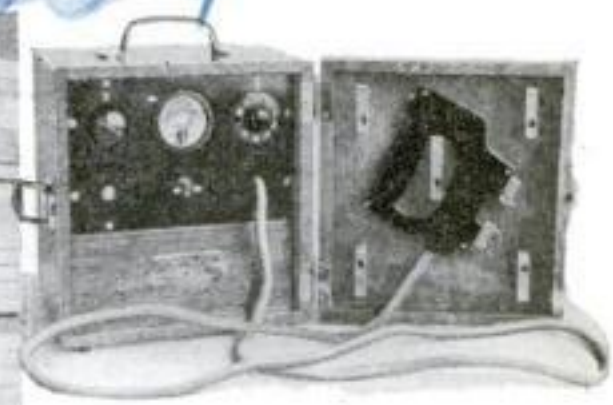
AN ARMY of Texas caterpillars, 20,000,000 strong, recently marched through parts of southeastern Australia, making a clean sweep of prickly pear plants. When this form of cactus began to overrun farms in New South Wales, the residents called for the help of a caterpillar living in the United States which feeds on the prickly pear. Twenty million eggs, shipped across the Pacific, were attached to the spines of the plants. The caterpillars, which issued from these eggs, made a mass attack upon the plant pest, giving valuable aid to the farmers.

Dampness of Lumber Measured Quick as Magic



The moisture detector attached to a high speed machine used for surfacing lumber.

Simply pressing electric contact points against boards in a lumber pile records their dampness.



The recording instrument, in which moisture in lumber is indicated on a dial.

HOW much moisture is there in a wooden board? An uncanny electrical machine, tested successfully by the National Lumber Manufacturers Association, tells instantly, eliminating guesswork. It is known as the Heppenstall moisture content detector.

A small handle, suggesting the detachable handle of a flatiron, is fitted with contact points connected with a source of electric power through a recording meter box. As the contact points are pressed against the lumber an electric current passes through the wood and, as if by magic, a dial within the box of the apparatus indicates the amount of moisture in the lumber.

The invention is based on the fact that the electrical conductivity of wood varies with its moisture content. The dial records the amount of current that passes from one pair of contact points to the other; the larger the amount of moisture, the larger the current.

When wood is tested in a lumberyard, the dial is set at the moisture content range within which the wood will be acceptable to the buyer. If the current registered is too strong, it will throw the needle beyond this point, marking the piece of lumber as unsatisfactory.

In the past, moisture content was determined by guesswork of men of years of experience, or by taking a piece of lumber, cutting off a sample, weighing it, putting it in an oven to dry for twenty-four hours or more, and then reweighing it, and finally applying mathematical formulae. Even this extensive test was not wholly satisfactory because it merely showed the moisture in one piece of lumber and not in all the pieces in a pile.

Another use for the new device is in connection with the work of painters. After a rainstorm, the workman can determine in a moment when the wood is dry enough to begin painting. The device has been found to work as well on wood that has been varnished or painted as on the uncoated timbers in a lumberyard.

Fight with Head-Hunters for Camphor Supply

TWO million of the 6,000,000 pounds of camphor imported into the United States last year came from the chemist's laboratories. Before the war, practically all camphor came from trees in Japan and Formosa in southeastern Asia. The collecting of camphor in the wild Formosan highlands is a hazardous occupation. Savage head-hunters menace the laborers, making military guards necessary.

The camphor is a dense-topped tree, similar to the laurel, growing from forty to sixty feet high. The felled tree is cut into fine chips and distilled with water. The vapor of the camphor rises with the steam and is conducted to a receptacle where it condenses. White blocks of camphor remain when the camphor oil is drained away.

The yield from a single tree is sometimes as great as 6,600 pounds, worth about $5,000. Recently it was discovered that the leaves could be made to yield more camphor than the wood and could be harvested without harming the trees.

Synthetic camphor is produced by chemical processes based on the conversion of pinene, a hydrocarbon existing in the volatile oil of turpentine.

Knows His Radio's Voice

A WEST COAST radio enthusiast, after having been robbed of his set recently, claimed to "recognize its voice" while passing the open window of an apartment. Police proved that the set with the distinctive "personality" belonged to the sharp-eared victim.

Double Keyboard Piano Plays Strange Music

CALLED "The Piano of the Future," a new musical instrument with a double keyboard has just been introduced into the United States. This invention of a Swiss instrument maker is said to make possible musical effects that cannot be obtained with the standard keyboard. For whereas half tones are the limit of the ordinary piano, the new instrument can sound quarter and eighth tones, enabling the musician to achieve new and subtle harmonies and produce fine differences of tone that only the trained ear can hear and recognize.

If the double keyboard piano comes into wide use, it may give rise to a new style of music taking advantage of the fine tone shadings it makes possible.

Vincenzo Bellezza, conductor in the Metropolitan Opera House, New York City, trying out the new double keyboard piano.

Light Remains a Mystery

WHAT is light? Still as much of a mystery as ever after centuries of research, Dr. Paul R. Heyl, of the U. S. Bureau of Standards, recently declared.

One school of scientists believes that a ray of light is a wave in motion in some all-pervading substance termed "ether" for lack of a better name. Another holds that it is actually a stream of material particles, or "corpuscles," that hit the eye. Advanced experimental work today shows that neither explanation fits all the observed facts about light. Perhaps, Dr. Heyl comments, a more general theory will be found, in which each idea will have a place.

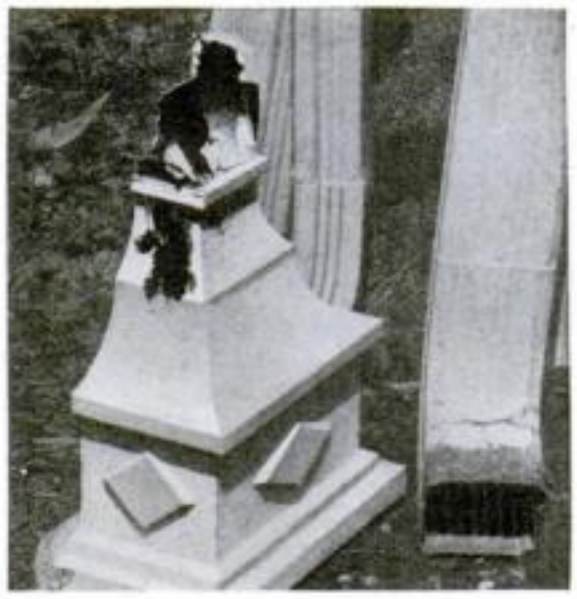
Why a "Cheap" House Costs Most

A copper leader head, good as ever after 144 years. Compare with the iron one opposite.

ARE you wondering how you can shave the price of that new home you are building? Are you planning luxuries and "trimmings" at the expense of durable construction? If so, it will pay you to read this article. Based on the long experience of experts, it reveals the pitfalls of "bargain-hunting," and will help you choose between spending reasonable sums for materials and workmanship or greater sums for maintenance and repairs.

By

MILTON G. STURGISS



Gone after three years—this galvanized iron leader head quickly rusted away.

TWO young couples settle in the attractive new homes, almost identical in appearance, which they have built just around the corner from each other. For a few months everything is well. And then—

In one house a water pipe bursts. Paint peels and flakes from the side of the dwelling. It settles on one side, and the plaster cracks. Joints open and cold air seeps in. The house is still as charming in appearance—from the outside—as the other. But life in it has become misery. Soon the owner, unable to bear the expense of maintaining it, will have to sell at a loss.

Why is this house seemingly "hoo-dooed," while the other is almost as good as new? The answer is found in the optimist-owner who decided he could not afford the dwelling he first had planned—and who found a builder who agreed to help him "economize." The "economy" consisted of follies. Footings, wide bases which are more expensive than plain construction, were omitted from the foundation. Cheap substitutes replaced linseed oil paint. By the time the house was finished it was a monument to false economy.

The mishaps that befell this dwelling may be expected to mar any home slapped together cheaply. It costs money to build on foundations that won't sink, to install pipes that won't rust, and to insulate the walls against heat and cold. But the money thus invested returns big dividends in reduced upkeep and added comfort.

How is the prospective home owner to distinguish between lavishness and false economy? To find out, I sought the advice of Clifford C. Wendehack, an architect who has designed many modern homes. He summed up his views by exclaiming, "The bargain-hunters in home building are the ones who get licked!"

The initial item of wise spending, he told me, comes before the first spadeful of earth is turned.

"Employing an honest and competent architect, and an honest and competent builder, are the two best guarantees for the owner's safety," Wendehack said. "These men share responsibility for turning your 'dream home' into reality. It will pay you to see that they are worthy of your confidence. You may hardly expect to find them by 'bargain-basement shopping.'"

I RECALLED the experience of a friend. The builder of his home, unknown to him, had decided he could pocket a little money by leaving out two of the middle columns that reach down through the cellar to support the house. Months later, when my friend found the whole floor sagging toward the center, he discovered every first floor beam cracked. It cost him $500 to repair the damage. By leaving out the vital posts, the "gyp" builder probably saved himself just about ten dollars, at five dollars per column!

From his long experience, Wendehack told me of the most frequent types of injudicious spenders.

"One of them," he said, "wants to spend his money on accessories instead of on the home itself. A thousand salesmen are out on the road trying to sell him new-fangled gadgets that get out of order and are never used. He might far better put his money in good honest construction and adequate insulation, heating, and ventilating.

"ANOTHER sort is the man with large ideas and a small pocketbook. It isn't always easy to convince him that by building large and cheaply he is 'spreading his butter too thin.' Such a house is excessively costly to maintain. The wise spender with not too much money will build small and sound."

If the owner insists on all the conveniences and luxuries he has admired in neighbors' homes—a second bathroom, perhaps, or tiling or a sun porch—the chances are he will get them, even if he cannot afford them, from a builder who is not over-conscientious. But make no mistake—he will not get something for nothing. In the hidden recesses of his dwelling, sound construction will be sacrificed to pay for the non-necessities.

What is "sound" construction? To

The builder saved a few dollars by neglecting to brace these houses, under construction. Then a seventy-mile gale came along, and here is the disastrous result. It doesn't pay to sacrifice principles of sound construction for fancy fittings and nonessentials.

Here is a typical, substantial American home, ornate and attractive, **yet s**olidly constructed of durable **materi**al throughout. It is good for **a cen**tury of service and comfort.

Courtesy C. C. Wendehack, Architect

begin with it is sturdy walls and roofing, with bracing and fire-stops, adequate framing, and a solid foundation. An honest builder will avoid supporting floor beams on a chimney instead of on a frame built around it, because he knows that the chimney, settling under the weight, will skew the framework and crack the plaster.

PLUMBING is doubly important today because the concealed pipes of modern dwellings must be trouble-proof. Galvanized steel pipe is cheap. But no home owner who has torn out a section of wall to repair a leak will recommend it. Water absorbs air and chemicals that readily attack the pipe. Rust follows, accelerated when the water is hot. Moreover, water pressures are higher today than formerly, and that, too, hastens corrosion. The only remedy is to use pipe that positively will not rust, such as brass pipe. In a $12,000 house, say, that may mean an additional cost of $65 or so. Many builders and architects agree that it is one of the best ways in the world to spend $65.

Wooden shingles, with proper care, will provide a satisfactory roof for a few years. But are they cheapest in the long run? The cost of keeping them painted and repaired may be as much as from thirty to fifty per-cent of the entire roof's cost when from seven to ten years have elapsed. At the end of this time patching will no longer keep rain out, and a new roof is obligatory. An owner who paid $300 more for a roof of more permanent material considered the eighteen dollars annual interest on his money well spent.

Considered as a business proposition, instead of "just another expense," the idea of lining the walls and roof with heat-insulating material is sound common sense. It is not unusual for an owner who has spent from $50 to $75 on insulation to pay for it in reduced coal bills within two or three years—and thereafter pocket the saving himself. One man added weather-stripping on doors and windows and storm sashes on the exposed sides of his home, at a total cost of $600. He pays $36 a year more than his neighbor in interest—but he saves $60 a winter in coal bills!

The solid stonework and brass hardware of this fine entrance have withstood the elements for 116 years!

Downspouts and gutters account for 250 feet of trouble on the average home—unless they are made of nonrusting materials such as copper. Rustable hardware looks well for a year or two, and then streaks appear on the painted woodwork below it. It is a startling fact that rust costs the home owners of the United States $575,000,000 a year—some five times as much as their loss by fire. For permanence select metals and alloys which, because of their peculiarly resistant qualities, do not rust—even though the first cost is a little greater.

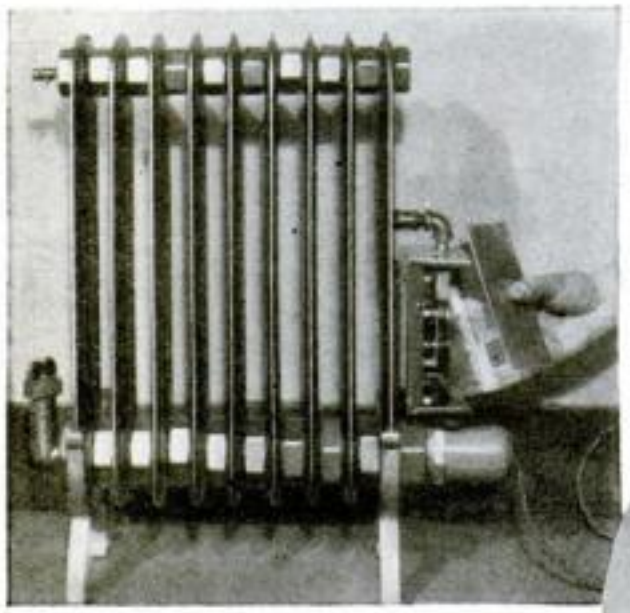
A carefully planned "budget" may point the way to sensible economies that do not imperil the permanence of the home. Here is a typical analysis of what happens to your building dollar based on the actual construction costs of nine houses of varying prices ranging all the way from $9,100 to $23,000 and averaging $15,000:

FOR excavating and grading, $0.02. Masonry, $0.09. Stucco, plaster, and tile work, $0.10. Carpentry, $0.27. Roofing, $0.05. Flashing, downspouts, and gutters (nonrustable), $0.01. Plumbing (noncorrodible pipes), $0.10. Heating, $0.07. Electric wiring and fixtures, $0.03. Hardware, $0.03. Painting and glazing, $0.04. Screens, $0.01.

That makes a total of eighty-two cents for construction costs. The remainder of your building dollar, minus a small (*Continued on page 156*)

New Conveniences for the Home

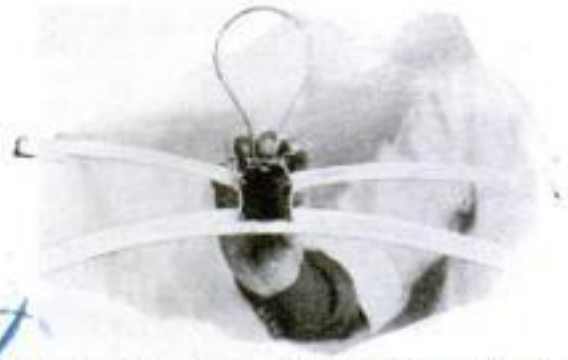
This newest of electric servants scours pots and pans, whips cream, mixes batter, beats eggs, and extracts fruit juice. A flexible shaft leads from a motor on the wall to interchangeable power tools in its working end.



Light enough to carry anywhere, this new electric brass radiator plugs into wall socket and "makes its own steam heat by wire." Automatic controls regulate steam pressure.

Adjustable to sixteen different sizes, these casserole and pie plate holders will stretch or shrink to fit plates up to ten inches in diameter.

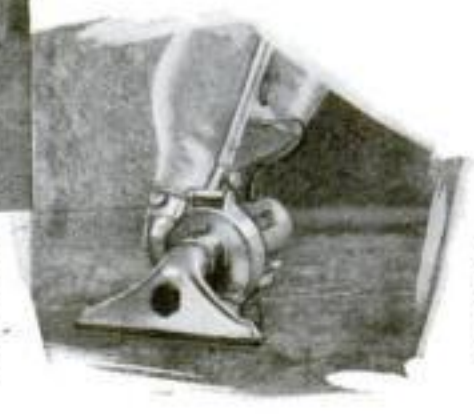
Snap a new metal lid on your milk bottle, and it becomes a pitcher. The aluminum cap replaces the paper seal and insures cleanliness and purity; hinged flap opens automatically when the bottle is tilted.



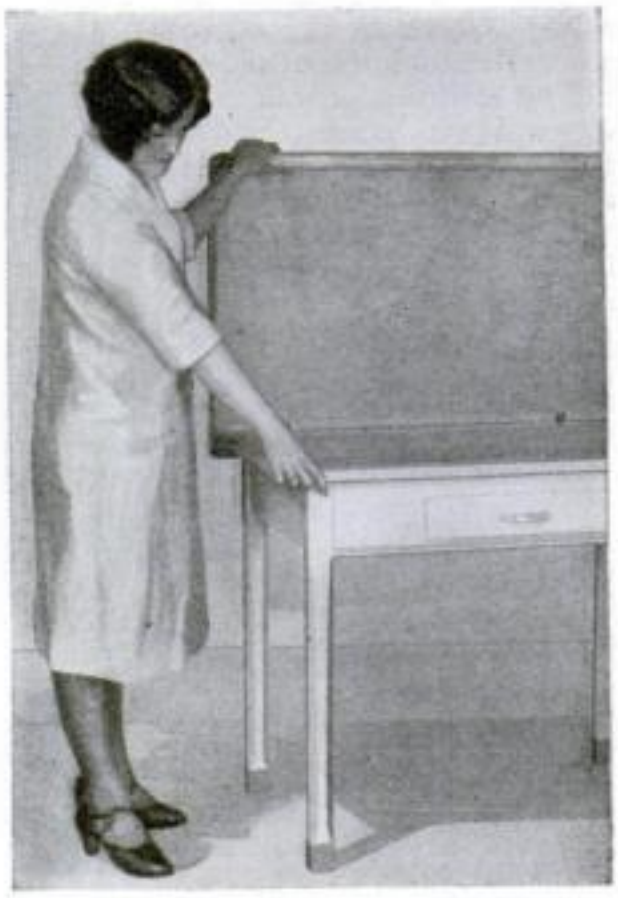
Dresses cannot slide from this new hanger with double arms. A spring clamps upper arms down when the gown is hung on the lower.

After you have swept the carpet with a new vacuum cleaner, you can detach the motor, transfer it to a floor-polishing machine, and polish the floor. Like the electric motor, handle is interchangeable.

To keep crackers crisp, or coffee from losing strength, these new food jars have a special latch cover that seals them moisture-tight.



At left is a close-up view of the new vacuum cleaner with demountable motor which can be attached to a floor-polishing machine.

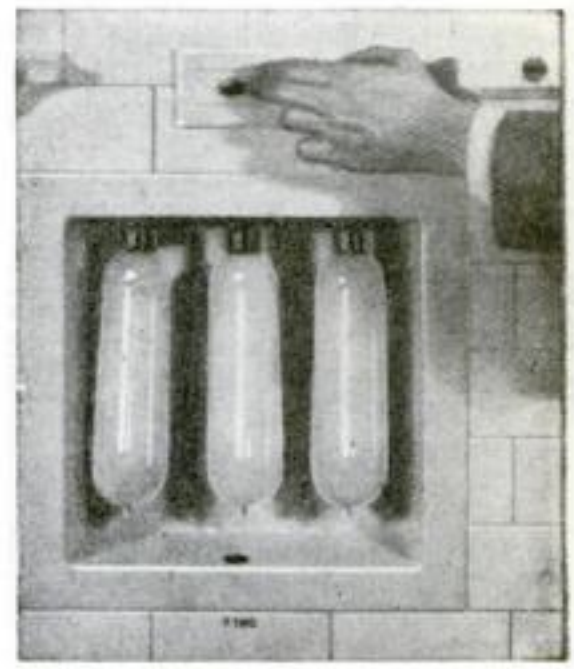


Raising the white enameled lid of this ingenious kitchen table exposes a wooden top for pastry making. The two tops also may be extended, side by side, to provide space of double width.

WHETHER You're the Housewife or Man of the House, You'll Be Interested in the Month's Most Useful Ideas for Your Comfort

Just a snap, and this sliding **closet** bar for clothes **hangers** goes into action—**without screws, hooks, or holders. Slide it out until it fits the closet, close a locking lever that squeezes its rubber tipped supports against the walls, and it is there to stay. It takes thirty seconds to install.**

Adjustable in a second to a window of any size, this new telescoping ventilator keeps out drafts, as well as rain, snow, or dust. The window may be left part way open, thus assuring a continuous supply of fresh air.



It looks like a row of lamps set in the wall. Actually, though, it is a new bathroom heater, whose three lamp-like bulbs give off a powerful warming glow when turned on. The long bulbs are especially designed for heating.

A caster that can be adjusted to the desired height by turning a locking disk avoids supporting uneven table legs with paper shims. It is said to take the jiggle out of any furniture.

Unsightly telephone instruments and directories hide in this handy cabinet built into the wall. The middle recess holds the telephone itself, while a shelf below affords ample space for the books. At the top, behind a little carved door, the bell box is ingeniously hid from sight.

Like a folding screen, a handy new sewing cabinet swings open to stand beside the work chair. It contains a let-down shelf and two catch-all troughs; spindles lining right-hand side hold spools of thread.

Left: A combination electric iron and comb for renewing fur coats. Passing the iron over the fur is said to make it fluffy and to kill any moth grubs that may be hid there.

An oil-burning refrigerator is the latest. Its fuel is ordinary kerosene which, strange to say, supplies heat to chill the ice box. There are no moving parts. Once a day the pint fuel tank is filled and the burners are lit. When the flame goes out, after about an hour and a half, the refrigerator stays cold, its makers say. Ice cubes are also made.

This Model Broke *All* Records

And You Can Build One Like It—Complete Plans for the Morris Seaplane Which Set the World's Mark of 12½ Minutes

By VINCENT L. JOHNSTONE

With Permission of Tudor Morris

WITH a little perseverance and confidence, any boy can build a hydro model like that with which Tudor Morris established the new world's record of twelve minutes and thirty seconds.

His model flew so long and so far because it had more rubber and was more efficiently arranged than the competing models. He used the latest ideas in streamlined floats—a V-bottom in front, a slightly concave planing edge at the rear, and a shape something like a wing section so that the pontoons probably support their own weight in flight.

For constructing the model you will need the materials given in the accompanying list (page 104) as well as the following tools and supplies:

Small round-nose pliers; high-grade wire cutting pliers; a sharp knife; Nos. ½ and 00 sandpaper; large and small camel's-hair paint brushes; several dozen common pins; a metal bar, pipe, or soldering iron for heating bamboo; a ruler and a sharp, hard pencil; some pieces of corrugated cardboard on which to draw the full sized plan of each half of the wing and the elevator.

Slightly round the edges of the balsa wing beams (marked *B* in the list of materials). Morris tapered each beam slightly from about the center to one end. Make a full size drawing of both ends of the wing separately on pieces of corrugated cardboard.

BEND a piece of 1/16 by 1/8 in. bamboo to the form of the wing tip over a hot piece of pipe or soldering iron. Split the piece in two and scrape them with a knife so that they are exactly alike. Then round their edges.

The upper surface of bamboo should be scraped clean of its hard, brittle varnish, but right under the varnish is the toughest part of tne bamboo—the part that should be used. The part that comes from the inside of the pole should be thrown away.

It is easy to make two ribs at one time by splitting a wide piece of bamboo in the center repeatedly until you get a piece slightly wider than the two ribs. Then bend the ribs, split the strips in two, and scrape them to the size specified. Each rib should be about ¼ in. longer than the distance between the beams so that its ends can be pointed slightly and inserted into the beams.

To hold the joints use an ambroid type of cement. Keep the cement covered after each dip into the can by laying the lid upside down over the opening. If it becomes too thick, a very little pure banana oil can be mixed with it and shaken up well. The cement should be dropped on the work and spread quickly. It soon becomes like jelly, and if you interfere with it or move the joint at this time, the result will not be satisfactory.

LAY the beams on your full size pattern with their tapered ends out toward the wing tips and stick pins through the cardboard to hold them. Insert and cement the two ribs (marked *2* and *3*), making sure that the high part of their camber is to the front. When the cement is dry, notch the beam ends so that each wing tip will fit smoothly and cement the tip well. Lay a pencil under the very tip, as illustrated on page 104, while the cement dries. Do not insert the center rib.

When both halves are dry, turn them over and cement them slightly on the bottom side only. Also coat the center ends of the wing beams with cement to prepare them for being joined.

Place the two halves on a table so that the center of the beams touch each other. Block the wing tips up so that they are 2 in. off the table. The paper will warp the tips up 3/8 in. more. Now cement the beam joints with a very heavy coat.

When this is dry, coat again for ½ in. or more on each side of the joint. When it is thoroughly dry, turn the wing over and repeat the operation by putting two coats of cement on the bottom side. The wings then should be supported in the center as shown. The align-

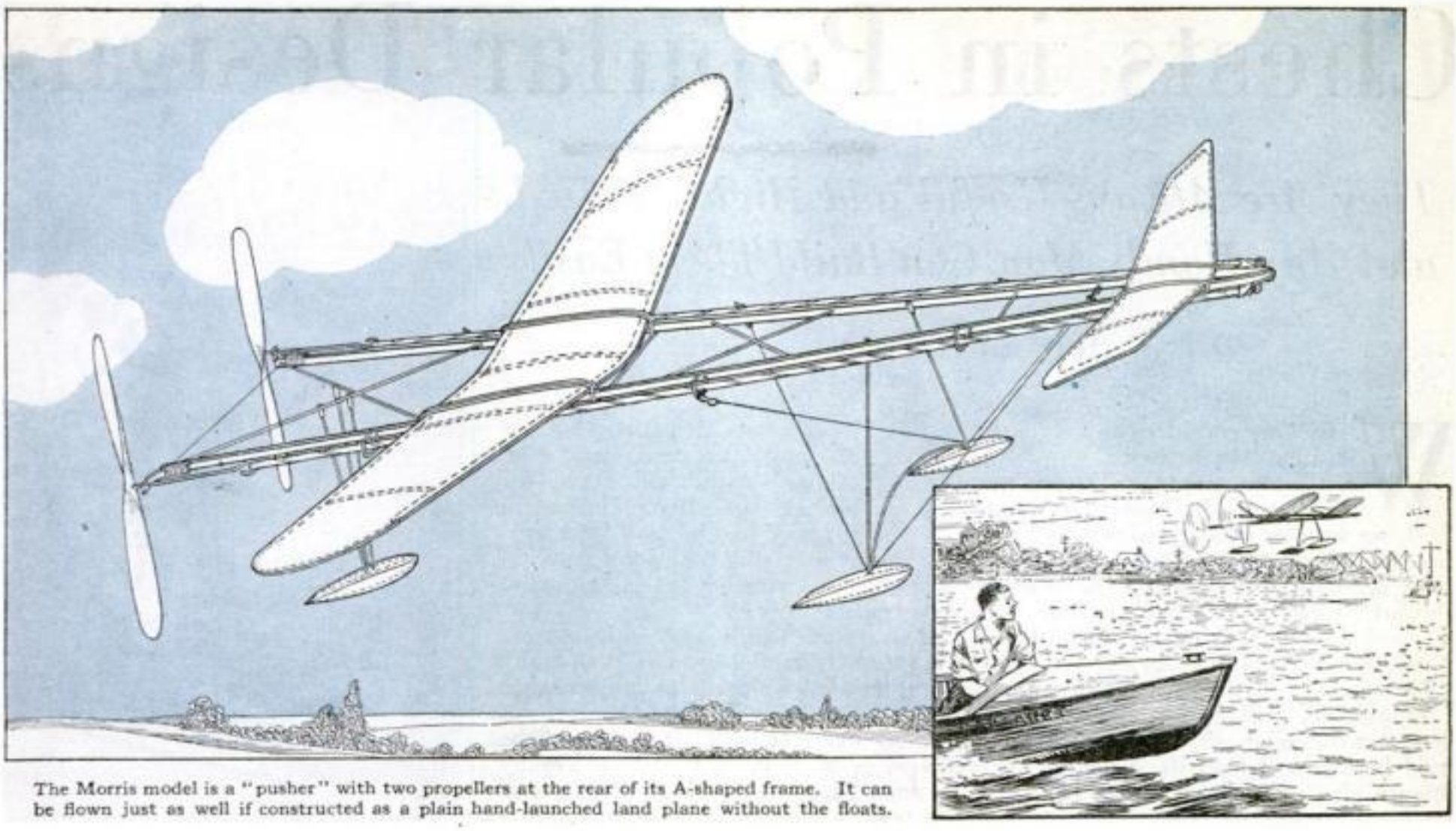
Tudor Morris with the model described in this article immediately after it made a new record at Atlantic City, N. J.

Our Blueprint Will Help You Build the Plane

A LAD of sixteen, who had been building airplane models for a little more than a year, launched a seaplane on a small pool at a flying field on the inland side of Atlantic City, N. J., during the last national contest conducted by the Playground and Recreation Association of America. It shot away on one of the most astounding flights in the history of model aviation, pursued by its builder on a bicycle and by contest officials and the author of this article in automobiles. It flew for twelve and a half minutes, setting a new world's record, and was picked up undamaged in the Atlantic Ocean three quarters of an hour later.

Tudor Morris was the builder of that model. He has checked the drawings and instructions of the accompanying article to make sure the design and dimensions are correct. This article is, therefore, a noteworthy addition to our long series of model airplane articles. Other articles on prize winning models are being prepared by Mr. Johnstone.

To make the work of building the Morris model easier for you, a blueprint has been prepared with larger drawings than it is possible to publish in the magazine. It is numbered 102 in the POPULAR SCIENCE MONTHLY series (see page 108).



The Morris model is a "pusher" with two propellers at the rear of its A-shaped frame. It can be flown just as well if constructed as a plain hand-launched land plane without the floats.

ment must be nothing less than perfect.

With a knife point, pierce the inside of the beams at the center joint and insert the center rib. A drop of cement at each end of this rib will finish the wing except for papering.

For a hydro model it is advisable to waterproof the Japanese silk tissue paper. Morris threaded a string through the long edge of the paper and, using a wide soft camel's-hair brush, covered the sheet quickly and evenly with a coat of light "dope." Th n he ironed his paper with a hot iron and gave it a shrinking treatment by alternately dipping it (by means of the string) in water and drying it. He ironed it again and soaked in water once more. The light dope is composed of about ½ oz. collodion or lacquer diluted with ½ oz. acetone.

Coat the beams and ribs all over with paper cement to waterproof them. The paper cement is a thin lacquer or collodion substance. Cut a piece of paper slightly larger than the surface to be covered. First wet the center rib with a second coat of paper cement and stick the paper to it. For a cambered wing it is best next to stick the paper to the second rib and then to the wing beams between the two ribs with very little stretching. Continue in the same way but do not try to paper too much at a time.

When the paper cement is dry, the margin can be cut off with a sharp razor or removed by sandpapering the outer edge lightly. It is well to leave a 1/16-in. margin and fold it back over the wing tip, using a little more paper cement. In several days atmospheric changes will improve the appearance of the wing by causing a slight additional shrinkage of the paper.

For the frame Morris used balsa wood, music wire, and bamboo. The edges of the motor base sticks *A* should be slightly rounded by sandpapering. The bamboo X-braces of bamboo are cut to size and the edges rounded by scraping to an oval section. For the rear brace it is necessary to have a very long jointless piece of bamboo—practically 15 in.

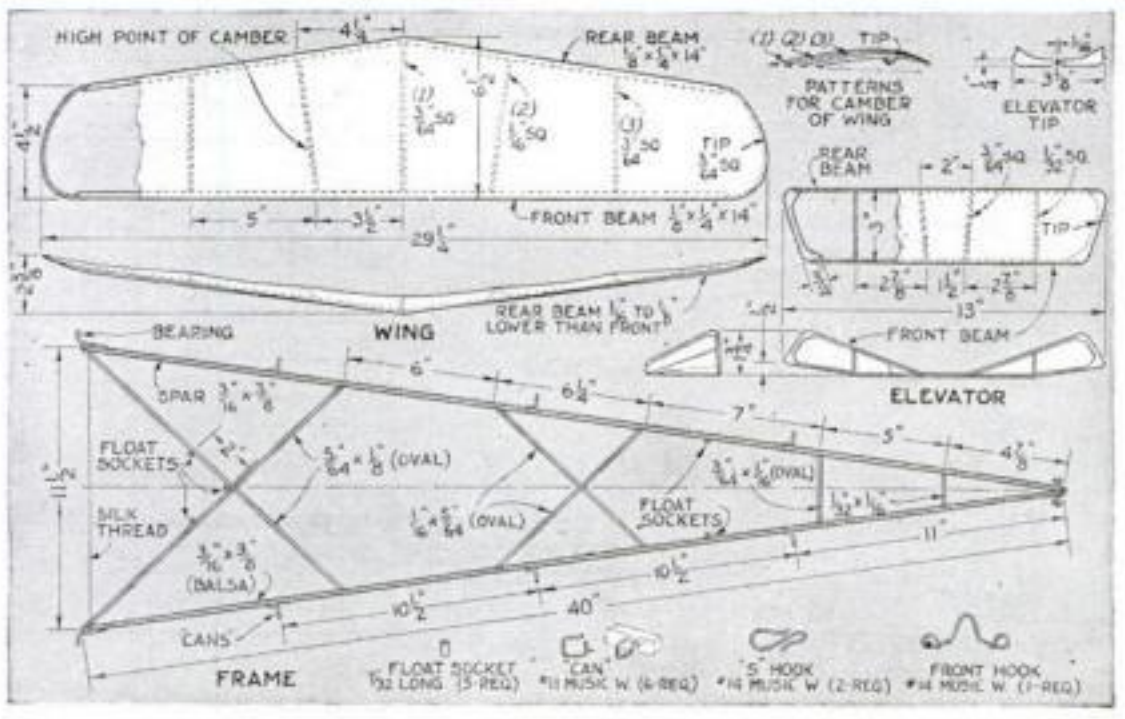
The wire parts are easy to make, especially if you use the full size patterns on Blueprint No. 102. Note that the "cans," of No. 11 music wire, have short prongs to be inserted in the motor base.

The bearings can be purchased from a model supply house or made by hammering or forging the ends of a 1/16-in. diameter finishing nail flat and drilling a small hole as shown.

Lay the two motor sticks side by side and with a pencil mark the locations of the cans and X-braces. Then dope all of the bamboo and balsa pieces with paper cement.

Point the rear ends of the sticks or taper them down towards the center. Cut the front of the sticks to fit together in such a way that the rear ends of the spars will be 11½ in. apart. Dip the two ends of both sticks in cement about ½ in. deep and allow to dry.

Smear a little cement over the inside faces of the angle joint at the front and place the spars firmly together while you slip the front hook or yolk in place. Fasten it securely to the nose with several coats of cement. Before it dries, check the space between the rear ends of the spars. When the cement is dry, you can proceed to assemble the bracings.



Top and front views of the wings and the elevator; layout for the frame, which is of balsa wood and bamboo; and details of "cans," S-hooks, front hook, and float sockets.

Pierce the insides of the beams part way through and along the center line. Point the bamboo pieces on both ends and force them right through the frame as shown on page 104. Be very careful that you do not mistake the marks of the can locations for the bamboo bracing locations. Adjust the bamboo pieces in one of the frame members so that the ends will be flush with the outside surface; let the other ends project beyond the outside of the other frame spar.

Now carefully sight down the sticks

(*Continued on page 104*)

Chests in Popular Designs

They Are Always Useful and Highly Prized, and Any Handy Man Can Build Them Easily

By HAROLD P. STRAND

A chest seat like the drawing directly below.

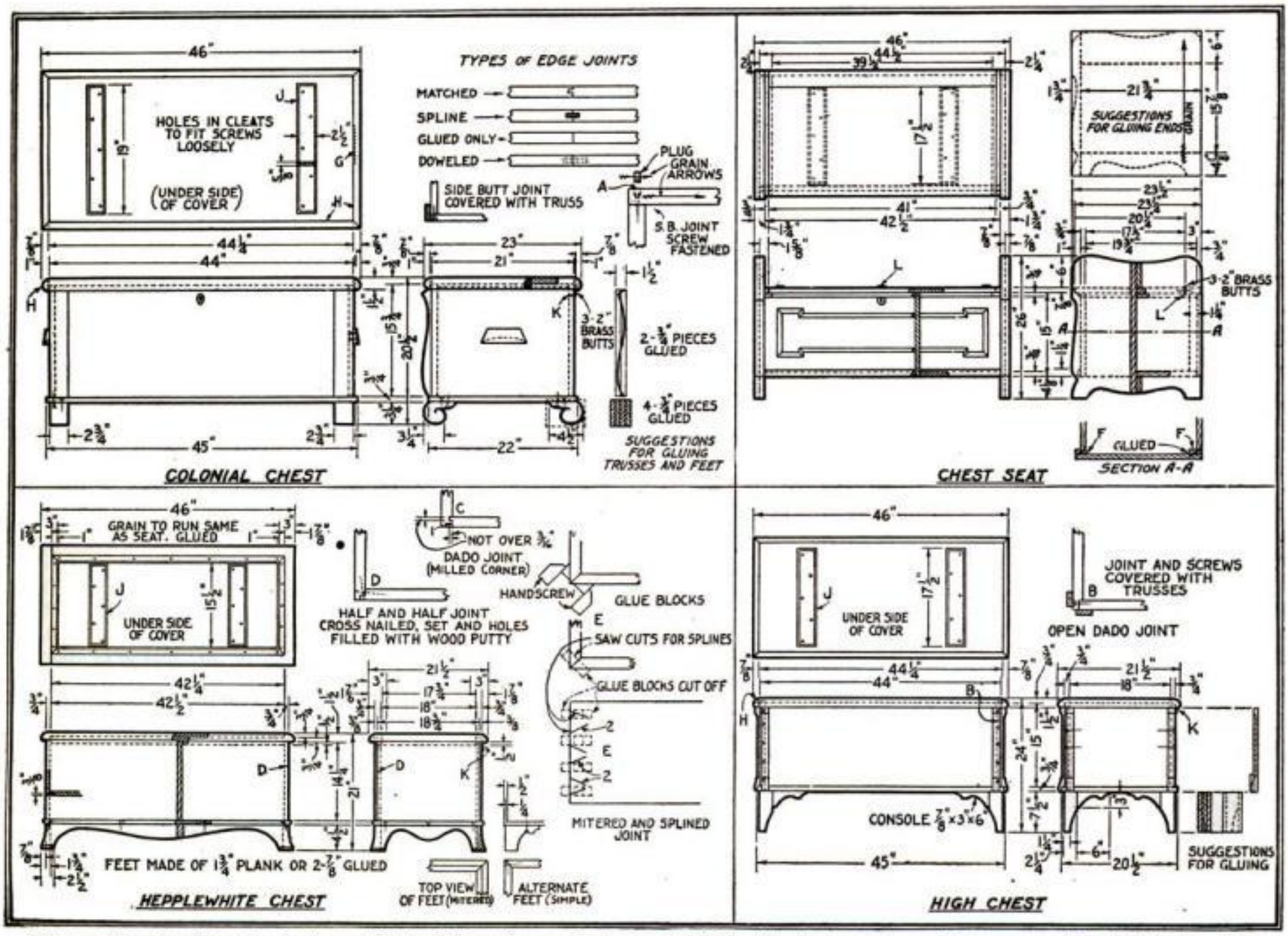
WHEN we consider the beauty, the romance, and the practical value of the cedar chest, we wonder what piece of furniture offers the amateur craftsman more satisfactory returns for his work. This article discusses the major points to be considered in making a Colonial and other popular types of cedar chests.

Thoroughly weather-dried red cedar, if obtainable, will yield more of the characteristic odor of cedar, but kiln-dried lumber will hold its shape better. Often a pine or whitewood chest can be lined with 3/16-in. red cedar, though as far as the safety of the contents is concerned, cedar may be omitted and the goods laid away in naphthalene flakes.

Cedar is prized for its beauty, its odor, and the sentiment attached to it through its long use in chests, but for all practical purposes any good cabinet wood will serve for making the chests illustrated. Plywood can be used by adapting dimensions to the differences in thickness; this will eliminate all gluing of wide boards.

Red cedar boards are seldom more than 8 in. wide and usually have many blemishes, but we must be thankful that the unwise lumber waste of the past has left us even these. They should be planed 3/4 or 7/8 in. in thickness, as may be required. If a tray is desired, one of the poorer boards may be resawed and planed to 3/8 in.

Saw out the boards to 1 in. longer than required and make a liberal allowance for width. Joint (plane) the edges for gluing. The simplest joint—the plain glued joint—has no reinforcement; the doweled joint is the best for this work, for the matched and splined joints though good, are (Continued on page 128)



Four working plans for cedar chests, and details of the various methods for joining the edges of boards and the corners of chests and building up the feet. The chests can be made larger or smaller, if desired, and the dimensions modified to suit whatever material happens to be available.

How to Turn and Inlay Trays

Three Attractive Designs Which Open a Fascinating Field of Work for Those Who Own Wood Turning Lathes

By HERMAN HJORTH

35e64

EVERY amateur woodworker who possesses a small modern lathe will find pleasure in turning attractive wooden trays, which are not only of considerable utility but also of real intrinsic value. By the addition of decorative inlays it is possible to increase the technical interest of the tool work and at the same time enhance the beauty of the designs.

In developing these projects, tool processes are involved in faceplate and chuck turning that are a step in advance of those described in previous articles of this series. To the wood turner who has mastered the simpler operations, the making of trays will offer no difficulty, yet will open a new and fascinating field for developing individual designs.

Splitting the waste stock from a turned tray, which is easy to do because paper has been glued between the two pieces.

The tray illustrated in Fig. 1 is turned from a solid circular disk not less than 1⅛ in. thick and 6¼ in. in diameter. A circle 6¼ in. in diameter is scribed on the wood with a pair of dividers. The wood is then sawed as nearly round as possible and screwed to a faceplate.

Its outside shape is first turned. For this work it is advisable to use a template of cardboard or thin wood such as shown in Fig. 2. If it is to be guided properly, the template should bear against a flat surface—in this case the underside of the tray. The recess in this surface is therefore cut after the outside shape of the tray has been completed. Obviously, the purpose of this bottom recess is to make the tray stand well on a flat surface.

The tray is now unscrewed from the faceplate and chucked as in Fig. 3. It is well to support it during the hollowing-out process by running the dead center up against it. When the tray has been hollowed to the extent shown in Fig. 3, the tailstock is moved out of the way and the central part turned down level with the rest of the bottom.

ON THE half plan, Fig. 1, is shown a circular inset, which is inlaid in the bottom of the tray. Such insets are sold by manufacturers of marquetry and are inexpensive. They are made up of many separate small pieces of wood about 1/28 in. thick, which are glued to a piece of brown paper. A piece of veneer surrounds the inset for protection; it should be carefully cut away with a pocketknife.

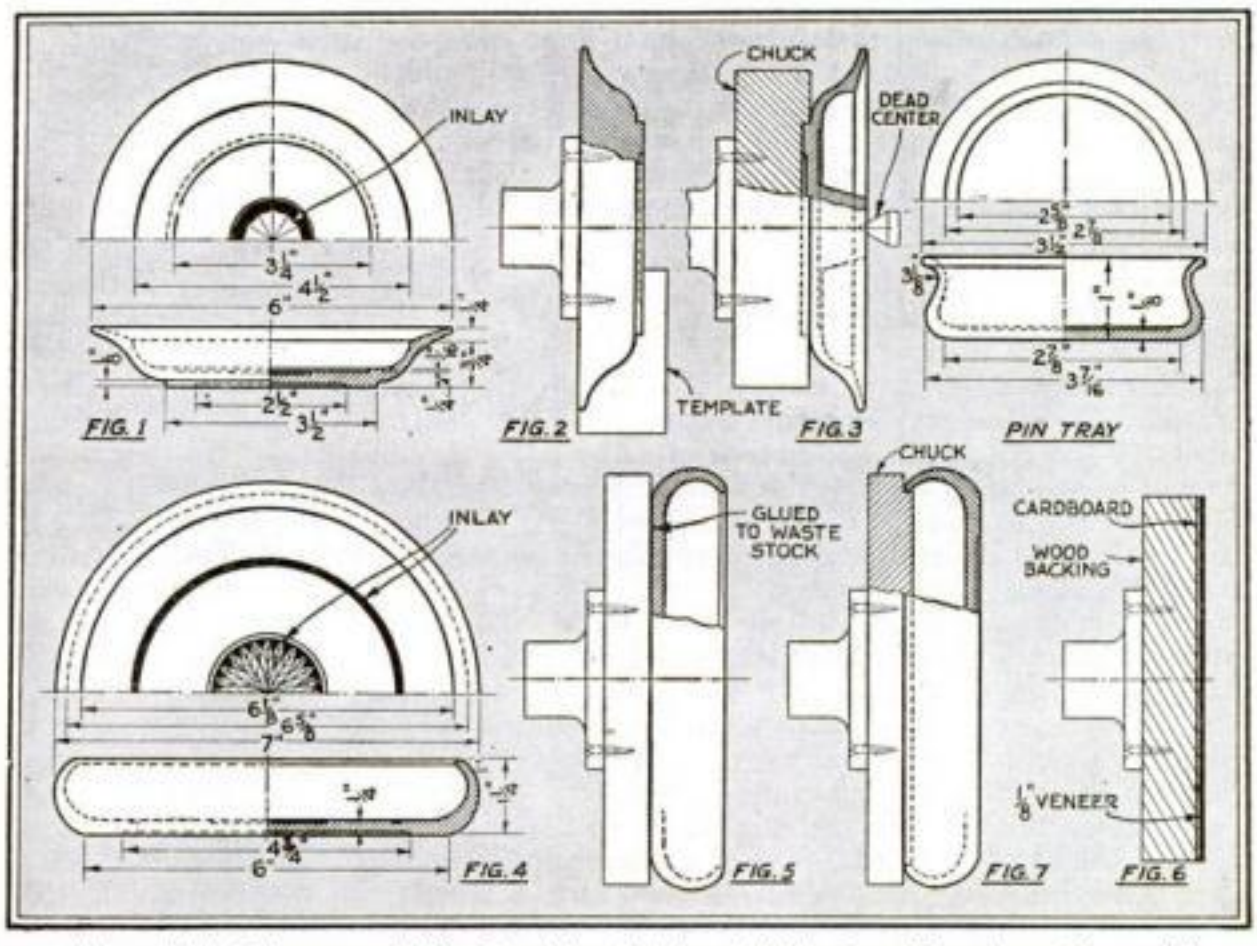
A shallow recess of the correct diameter to receive the inset is cut with a skew chisel in the bottom of the tray. The inset is glued into this recess face down, that is, with the papered surface towards the top of the tray. If glue were applied to the papered surface, a good bond would not be made, because the paper might split and parts of the inset come loose.

The gluing may be done by clamping a block of wood over the inset, which should be allowed to dry for at least six hours. Then the bottom of the tray is faced off and sandpapered smooth. The brown paper is removed by this process and the inset now stands out clearly and beautifully.

The tray shown in Fig. 4 is turned by a process known as "gluing to waste stock." This is done as follows:

Turn a circular disk of the proper diameter and face it off very carefully, so that it is absolutely flat and level (see the Oct. 1928 issue of POPULAR SCIENCE MONTHLY, page 112). Prepare the stock from which the tray is to be turned. Plane one of its surfaces true and level and saw the stock to the required diameter.

GLUE the planed surface of the tray to the waste stock, but *place a piece of paper between the two glued surfaces.* In order to center the stock for the tray accurately, first glue the paper to the waste stock and then mark the diameter of the tray on this papered surface with a pencil. This is easily done while the waste stock is revolving in the lathe. Remove it from the lathe and glue and clamp the stock for the tray securely to it as shown in the photograph on page 122. When the glue is thoroughly dry, (*Continued on page 122*)



A tray with inlaid ornament (Fig. 1) and how it is turned (Figs. 2 and 3); a tray with an additional line or band of inlay (Figs. 4, 5, 6, and 7); and a supplementary design for a pin tray.

Popular Science
MONTHLY

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Who Is Fit to Fly?

ELSEWHERE in this issue, a young man, telling of his experiences in learning to fly, describes the rigorous physical examination which all who would pilot airplanes must undergo. This test is more than an idle gesture. It is of the utmost importance. From Icarus, in the ancient Greek legend, to Lindbergh today, all who have tried to conquer the air have had to conquer their own physical deficiencies as well.

The airman must have a quick, alert mind, keen senses, and organs able to withstand unusual strain. His eyes must scan the skies and earth for weather changes, landing fields, and possible dangers; at night, they must penetrate the darkness to recognize lights and landmarks.

The strain on the ears, too, is considerable; the roar of a 200-horsepower engine is terrific, and it is most important that hearing should be sound in the aspiring flyer. His respiratory organs should be able to withstand continuous exposure to cold and wind. Last, but not least, his nervous system should be finely attuned but strong and flawless, for an aviator suffering from a neurosis may expect about as much success in his career as a tone-deaf musician.

The Government is right in insisting that only the physically fit shall learn to fly.

More Machines—Better Jobs

"ONE of the most important problems affecting labor today," President William Green recently said to members of the American Federation of Labor, "is the displacement of workmen by machines and devices which automatically do the work once done by trained men." He went on to say that the Federation will never allow a human scrap heap to be built up in this country.

The fact is that the use of more and more labor-saving machinery cannot be stopped—at least can be stopped only by a paralysis of American industry. But a larger use of machinery will not produce a human scrap heap. It will do just the reverse, as it has been doing for the last hundred years. Devices for spray painting, for example, making it possible for one man to do the work of three, have given house painters more work than ever before. Lowered costs result in surfaces being painted that never were painted before, such as stucco.

America today differs from the America of a hundred years ago, chiefly in comforts and luxuries made possible by mass production with labor-saving machinery. High wages depend on large consumption and large consumption depends on making products plentiful and cheap, usually an impossibility without machinery. History shows that as soon as adjustments are made after machines release men from drudgery, conditions improve for everybody, including the men temporarily distressed.

Those who have at heart the good of American labor should remember that it is machinery which has made the wage scale and standard of living of the American workman the highest in the world. No, Mr. Green need not worry.

Back of the News

SO OFTEN when we read of a scientific discovery, we fail to grasp it thoroughly. We are not quite sure of what preceded it or of its place in the scheme of things. No one of us can be thoroughly conversant with all of the wide fields of science.

It is in an effort to give to our readers that necessary background of fact that we have added the feature called "Back of the Month's News," to be found on page forty-eight. If it helps you to a new perspective, or a larger understanding, of current news, its purpose will be accomplished.

Wherever men are doing new and useful things, or thinking unusual thoughts, there you will find writers for POPULAR SCIENCE MONTHLY endeavoring to present these ideas and discoveries in words anyone can grasp. In this magazine, month after month, you will find articles designed to keep you abreast of rapidly changing world. In it you will always find not only the news of progress, but the stories behind that news.

What Television Offers

A READER in Topeka asks if he should buy a radio set or "wait a few months until television sets are perfected." By television, he explains, he means something that will produce in his home a sharp, clear motion picture of a football game, for example. Our advice is to buy the radio set; he probably will have to wait too long for his television set.

Remarkable advances have been made in television, it is true, but many mechanical and electrical difficulties have yet to be overcome. Under the best possible conditions, with the most advanced apparatus known, it is limited today to reproducing a small, poorly defined, image of a person or object placed within a few feet of the scanning apparatus in the broadcasting station. Slow motion, such as the smoke curling from a cigarette, also can be transmitted. But even these meager results are possible only with perfect mechanical and atmospheric conditions.

Television, in its present stage of development, will fall far short of satisfying our Topeka reader. But it does offer a fascinating new field for the experimenter. Lurking around the corner for him is the possibility of making television as useful as is radio, a discovery that will bring fame and riches.

They Are Saying

"THIS globe has been inhabited by intelligent people millions of times. I am sure they had the automobile, the radio, and the airplane, or their equivalent."—Henry Ford.

"Asleep, men are thirty percent more restless than women, and the deepest sleep occurs from a half to three quarters of an hour after retiring."—Dr. H. M. Johnson, Mellon Institute of Industrial Research.

"If every man, woman, and child had $500,000,000,000, and each dollar represented an atom, their total wealth would still fall short of the number of atoms in a drop of water."—Owen D. Young, General Electric Co.

"The moon was once part of the earth and was pulled away from it."—Sir Oliver Lodge.

"The public will have it that I am going merely to fly over the pole, when in fact we are going to fly over a vast territory, never seen by man, photographing it as we fly."—Commander Richard E. Byrd.

"Certain glands alter the stature, the length of limb, the size of the neck, the size of the jaws, the shape of the nose, the modeling of the forehead, and the texture of the skin.—Sir Arthur Keith, British anthropologist.

"The invention of the airplane and the radio are perhaps one-tenth as useful as some of the discoveries in pure science."—Dr. Robert A. Millikan.

GOUGING OUT THE RIVER BEDS WITH THE HELP OF SKF BEARINGS

MEN who build the great mechanical monsters that perform the Herculean tasks of the world don't think of construction units in terms of PURCHASE PRICE. They think of them in terms of what they will do—of the FINAL cost reckoning at the finish of the job.

It is significant that the U. S. Engineer Department as well as practically all the biggest engineering companies in the country has selected SKF Bearings for heavy marine equipment such as dredge pumps, cutter head drives and tow boats.

In dredging and other marine work as in all other tasks in which bearings play a vital part, "Nothing Is Apt To Cost So Much As The Bearings That Cost So Little."

You men who plan, build, use or pay for machines of any kind, remember this: It costs more to replace a poor bearing than to buy the best one that SKF ever produced.

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"THE HIGHEST PRICED BEARING IN THE WORLD"

How the Ignition System Works

A Driver Stalled on The Highway Has Gus Explain its Secrets

By MARTIN BUNN

Gus raised the hood and removed the distributor head. Then he examined the contact points, got a wrench, and made an adjustment. "Now try it," he said. The motor started at once.

HARNETT was bubbling with indignation. His trim, white mustache twitched like an angry rabbit's.

"You fellows think you're slick, don't you?" he rasped. "Try to trim me, will you? That new garage down the street'll do the job for half your price, and I'm heading for there right now, by Henry!"

"Sorry you feel that way about it, Mr. Harnett," said Gus Wilson mildly. "We quoted you a fair price for overhauling the ignition system on a car like this. It was as low as we could make it for a good job, and that's the only kind we do here at the Model Garage."

"Save the bunk for someone else!" the angry man growled as he slammed the door of his car. "It'll be a long cold day before you see me around here again!"

"Another good customer gone," groaned Joe Clark, partner of Gus in the Model Garage, as the car rolled away. "That new garage will take all our business away if we don't watch out."

"I'm not worrying so long as we turn out good work at fair prices," Gus smiled. "After that robber's roost down there stings him good and proper he'll be glad to come back to us!"

A few weeks later, Joe popped out of the tiny office with a broad grin on his face.

"You win, Gus," he said. "Harnett's on the wire. Says he's stuck about five miles down the road and will you please come and get him."

Harnett was sitting behind the wheel with a glum expression on his face as Gus drove up with the service car.

"I'll apologize for what I said the last time I saw you," he smiled sheepishly. "I didn't know good work when I was getting it until those high-binders played me for a soft snap. They didn't charge much, but they didn't do anything. This makes the third time the ignition has given out. They said it was all right just before I drove out here."

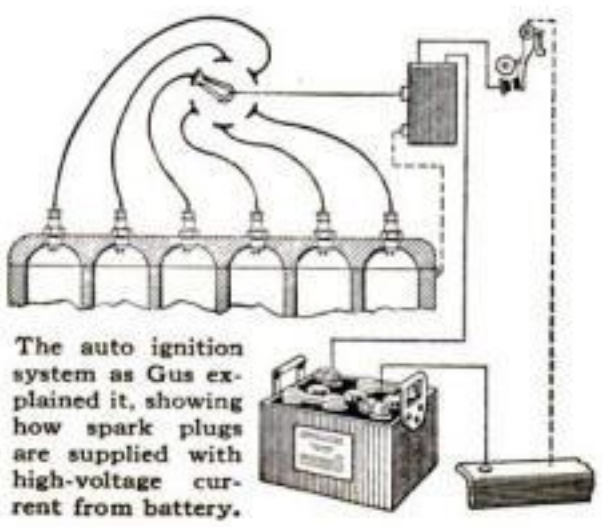
Gus raised the hood and removed the distributor head. Then he examined the contact points. He got out a tiny wrench, made a slight adjustment, and replaced the distributor head. "Now try it," he ordered.

Harnett stepped on the starter and to his amazement the motor started at once.

"As easy as that!" he marveled. "Say, Gus, stick an extra five spot on the bill and see if you can't get it into my thick head just how an ignition system works. I'm tired of getting stuck on the road with little troubles just because I don't know the first thing about it."

"Glad to," agreed Gus. "Follow me back to the garage where we can be comfortable.

"NOW," he continued, when they were seated in his office, "this ignition business turns out to be simple when you get right down to its workings." He drew paper and pencil from one of his pockets. "First we'll draw a storage battery, because that's where the juice comes from. Storage battery juice hasn't much kick behind it, only six volts. That's not much pressure, but there's plenty of current. Sort of like a big pipe with a lot of water flowing through it at low pressure. If you slapped a nozzle on the end of such a pipe it wouldn't squirt out like a fire hose. It'd just ooze out.



The auto ignition system as Gus explained it, showing how spark plugs are supplied with high-voltage current from battery.

"IF YOU put a current of electricity with no more push behind it than that up against the job of jumping the gap in a spark plug, it couldn't come near making the grade. So what has to be done is to take that low pressure current and use it to produce a current with a whole lot of pep. Sounds like trying to pull yourself up by your boot straps, but it really isn't because we don't need much current at the peppy, high voltage. We can sacrifice most of the volume to gain pressure."

"Then," interrupted Harnett, "if you get electricity at high enough pressure it will squirt off the end of a wire like water out of a fire hose?"

"In a way," Gus explained, "only the water will squirt in any old direction, while the high-voltage electric current will only jump across a gap in the circuit. Electricity always flows in a circle back to where it started from.

"But let's just forget about ignition switches and other fancy business and see what we actually do with the six-volt battery current. This little square thing I'm drawing now is supposed to be the spark coil, and this funny gadget right next to it is the contact breaker or timer. One terminal of the battery is wired to the frame of the car and there's a wire from the other pole of the battery to the spark coil. Then there's a wire from the spark coil to the insulated, stationary contact point in the timer. We'll put in a dotted line to represent the path of the current from the moving contact of the timer back to the battery by way of the frame. That's all there is to the primary or battery circuit except the ignition switch that we won't bother about, and a fixed condenser connected across the contact points of the timer."

"THE timer is what you fixed on my car?" Harnett questioned.

"That's right," Gus answered. "There was nothing the matter with your timer except that the boob who adjusted it forgot to tighten the lock nut and the stationary contact backed away until the moving contact couldn't touch it at all."

"What does the battery juice do inside the coil?" asked Harnett.

"I was coming to that," Gus explained. "All it does is to circulate around a coil of heavy wire.

(Continued on page 136)

RCA

Look for this mark on every Radiotron

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SAYS: "Exhaustive tests have demonstrated that RCA Radiotrons materially improve the reception of Crosley Radio sets. We consider them the highest attainment of vacuum tube efficiency."

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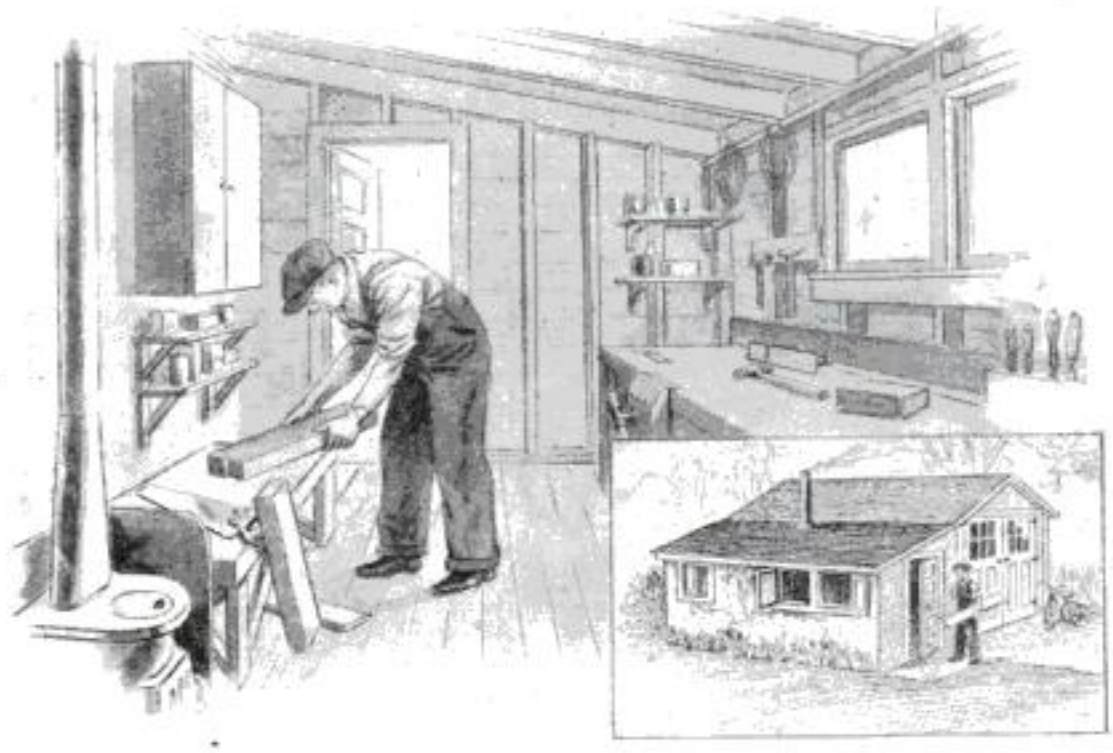


In this addition to his garage, Mr. Sibley, who is in the first rank of writers on handicraft for boys, solved the problem of finding a place for his home workshop.

I Add a Shop to My Garage

It Is an Ideal Place to Work Although Only a Small, Inexpensive Lean-to—How I Keep It in Good Order

By HI SIBLEY

NEARLY every normal man looks forward to having sooner or later a workshop of his own. And the present generation of boys, much handier with tools, it seems to me, than those of twenty-five years ago, need some place to build their airplanes and boats. A garage workshop like the one illustrated meets these demands exceptionally well.

In some parts of the country, as in the bungalow communities of California where the houses have small basements or none at all, a garage shop is, indeed, the only solution. In other sections also it has marked advantages over the average small, crowded, dark and sometimes damp basement, especially as it gives the boys a place to work as noisily as they please without disturbing other members of the family—an important consideration if motor-driven home workshop machines are used.

To build an addition to the garage for workshop purposes requires an investment of a little money and labor, but it will prove to be worth many times its cost. Incidentally, the aspect of your back yard will be improved, if anything, by relieving the harsh lines of the usual boxlike garage.

Unless you are an experienced builder, you will find it an economy to employ a carpenter for the construction work, but the interior you can fit up yourself.

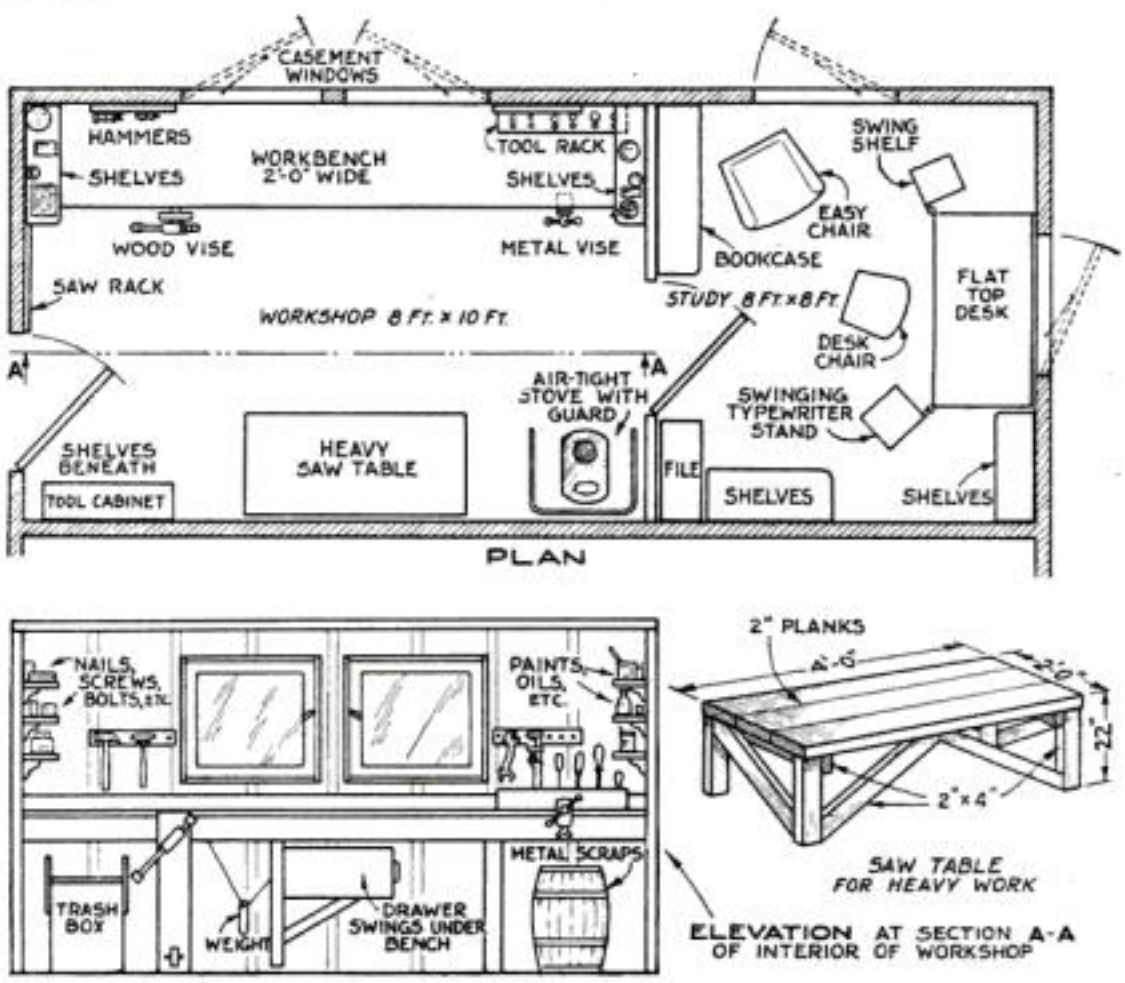
The addition to the writer's garage runs the full length and is 8 ft. wide. The original of the shop shown in the drawings was built a year ago and has been in daily use ever since. One end is partitioned off for a private studio, or office. This is neatly finished with wall board, the floor stained walnut; screens and curtains are hung, and furniture is installed as in the floor plan. Here one can work without fear of interruption by casual visitors, and a buzzer gives notice when there are phone calls or other business to be attended to in the house. In many cases there is no need for such a studio; then the entire lean-to can be given over to the workshop.

The workbench, 2 by 10 ft., is large enough for all ordinary jobs; and for heavy work, such as hammering metal or splitting blocks, there is a low saw table of 2-in. planks and 2 by 4's. It is very sturdy and survives much abuse.

Keeping any workshop neat is a problem. The best solution is to have a place for every tool, a receptacle, cupboard, or racks for unfinished work and useful pieces of wood, and receivers for shavings and blocks as well as tin and metal scraps. Every tool in this shop is returned to its place at night, and the floor is swept every morning.

For the edge tools and files, screw drivers, and the like, holes of varying diameters have been bored in blocks about 3 by 4 by 18 in. A block of this kind will hold anything from a 1/32-in. drill to a big wood rasp, and can be moved

(*Continued on page 126*)



Floor plan of the workshop and the adjoining study; an elevation of one wall of the shop, showing the workbench; and a sketch of the heavily built low saw table.

THE UGLY DUCKLING IN YOUR HOME . . .

DO YOU feel like hurling that mis-mated chair or table down the basement stairs?

Don't do it!

No matter how fiercely its finish and color clash with the rest of the furniture, there is just the right color among the many shades of Johnson's Wood Dye to make that "ugly duckling" glow with new beauty and in harmony with its fellows. No need now to retire it to kitchen or bedroom with an opaque makeshift finish which hides the innate beauty of grain and texture and bars it forever from the class of furniture to which it belongs.

Remove old varnish with varnish remover, or by scraping or sanding. Then as you spread the Dye over the wood it brings out the full richness of the grain in true, clear color and with none of that muddy, pigmented scum which poor stains leave. You'll find that it penetrates so deeply that no amount of scratching or marring will reveal the natural wood.

In 4 to 8 hours, the Dye is so thoroughly dry that it will not smudge or rub off, handle it as roughly as you will. It is ready for the professional touch of Johnson's Filler and surface finishes. Johnson's Spirit Wood Dye is preferable for use on old work, Johnson's Oil Wood Dye for new work. The latter dries thoroughly in 24 hours.

For that new radio cabinet, bookcase, or other unfinished furniture, you can get perfect hardwood effects, even on the softest wood, with Johnson's Wood Dye. You will be prouder than ever of your craftsmanship when you see how uniform and unchanging the Dye will color the things you build of wood.

JOHNSON'S WOOD DYE

S. C. JOHNSON & SON, RACINE, WISCONSIN

▲ ▲ ▲

FREE • A 25-CENT BOOK ON FINISHING. MAIL COUPON

Insist on Johnson's when you go to your hardware store. And to help you select correct colors and to follow best methods of finishing, there is a book on treatment of floors, woodwork, and furniture which you may have free for the asking. Fill out the coupon and send it today!

S. C. JOHNSON & SON, Dept. P. S., 3, RACINE, WISCONSIN

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You May Find Use for These Handy

Short Cuts for Car Owners

How to Fix a Broken Spark Plug, or Keep the Rain Out of the Ignition—Easy Way to Build Garage Door Stops

Fig. 1. If the outer point breaks, bend the inner point over close to the rim.

TWO common causes of spark plug failure are carbonization and burned or broken electrodes. An emergency repair for a broken electrode is shown in Fig. 1. Here the outer electrode is broken off. To make the spark plug work, simply bend the center electrode over close to the rim of the shell. This can be done, however, only if the center electrode is long enough.

A "Raincoat" for Ignition

WHEN a driving rainstorm blows drops of water through the louvres in the hood and the moisture gets all over the distributor head, many car owners have found to their sorrow that the motor will not start. The high tension current leaks away through the moisture instead of jumping the gaps in the spark plugs.

Figure 2 shows a novel way to get rid of this trouble. Take a child's rubber ball slightly larger in diameter than the distributor head and cut off the lower portion as shown. Next punch small holes for the ignition wires. They should be so small that you will have to force the wires through them. The edge of the large hole is pulled down around the edge of the distributor. If the ignition wires are good, this arrangement will be so nearly waterproof that you could pour a pail of water over the distributor head without affecting the operation of the car.

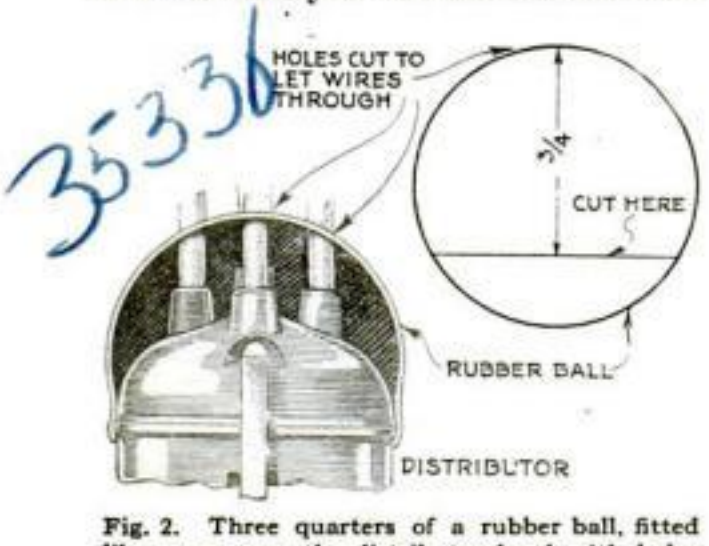


Fig. 2. Three quarters of a rubber ball, fitted like a cap over the distributor head, with holes for the wires, guards ignition from moisture.

Handy Garage Door Stop

FOR a simple and effective garage door stop, all you need is four pieces of board, some wood screws, four screw eyes, a foot of heavy wire, and two cheap strap hinges.

The illustration of Fig. 3 shows the construction. Two short pieces of board are fastened to the doors with wood screws, and to these are hinged two lower pieces which serve as the stops and swing upward when not in use. Then a pair of screw eyes are placed on each door, level with the points where the upward swinging stops strike the doors. To these the wires are fastened and bent to form two latches.

Fig. 3. These easily built garage door stops are made of hinged boards which fold upward and are held by latch when not in use.

Ten Dollars for an Idea!

W. Conway, of Syosset, N. Y., wins this month's $10 prize for his suggestion of a piston ring compressor, shown in Fig. 4. Each month POPULAR SCIENCE MONTHLY awards $10, in addition to regular space rates, for the best idea sent in for motorists. Other contributions used are paid for at the usual rates.

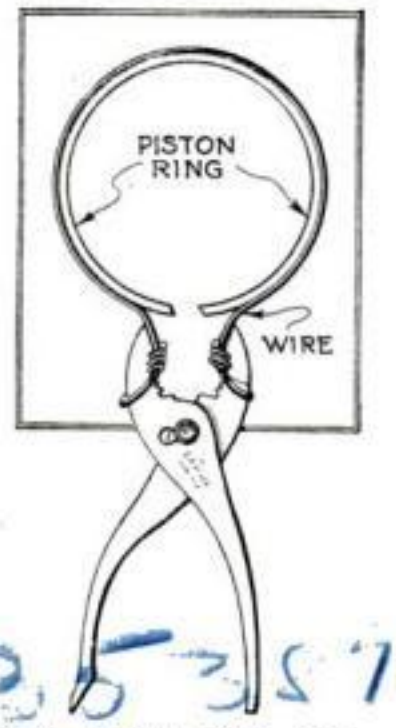


Fig. 4. Novel piston ring compressor made from pliers.

Piston Ring Compressor

FIGURE 4 shows an effective piston ring compressor made of a pair of adjustable pliers and a piece of strong iron wire. Success depends on how carefully you fit the ends of the wire to the jaws of the pliers. By fitting the wire so that the ring stands at right angles, it is possible to use this compressor in close quarters.

Sticking Tires Remedied

WHEN tires are left undisturbed on the rims for a long period, they frequently are rusted so tightly to the rims that it is extremely difficult to remove them. This sticking can be eliminated by fitting a band of zinc around the rim. Use thin stock for this work.

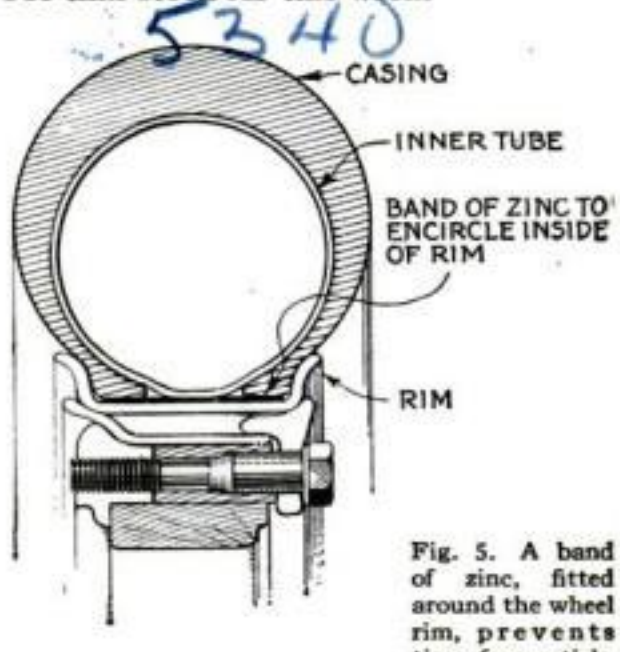


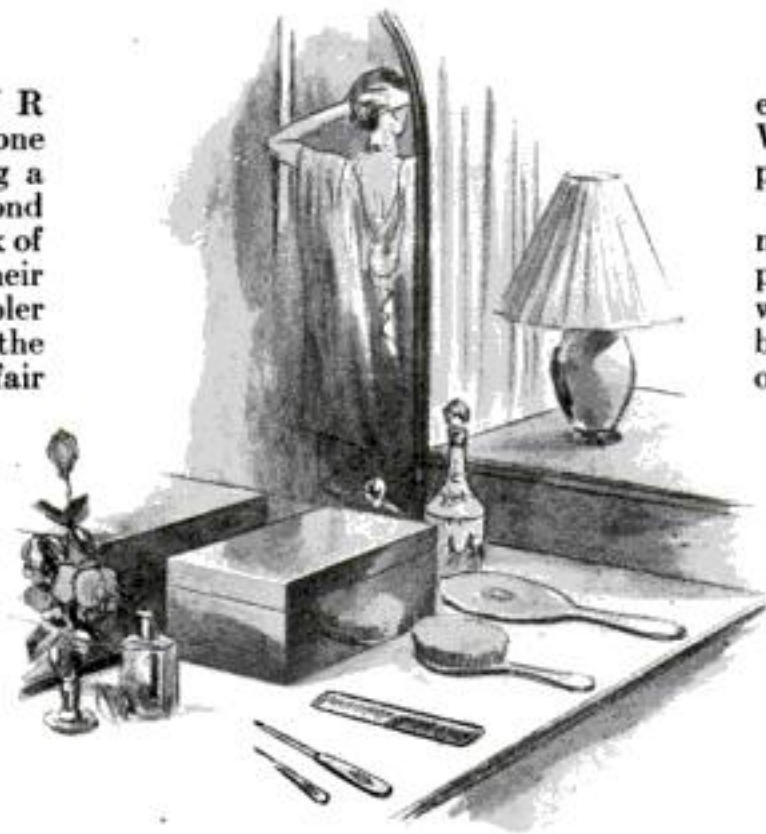
Fig. 5. A band of zinc, fitted around the wheel rim, prevents tires from sticking to the rim.

Veneering Isn't Hard to Do

And by Means of It You Can Cover Jewel Boxes and Other Pieces with Woods of Beautiful Grain and Color

By CHARLES A. KING

AMATEUR woodworkers are prone to consider veneering a phase of woodworking entirely beyond the range of their abilities and to speak of it with a note of awe and longing in their voices. To demonstrate that the simpler forms of veneering are not beyond the abilities of any home worker with a fair degree of skill, I shall describe the making of a veneered box which any young lady will value as a gift from her father, her brother, or even more from some other girl's brother.



Attractive pieces like this trinket case or jewel box can be made by the woodworker who learns the art of veneering.

The box itself may be made of any easily worked, thoroughly seasoned ½ in. thick wood, but the veneer should be mahogany, rosewood, walnut, or other fancy wood. Veneers can be purchased from some lumber dealers, from many plywood manufacturers and dealers in fancy woods, and usually from cabinetmakers and furniture repair men.

The corners and the top and bottom of the box should be made with halved joints to reduce the amount of visible end wood, which might show beneath the veneer under certain circumstances. Fit the joints carefully to insure squareness, and glue and nail the parts together with 1-in. No. 16 brads, being careful that the nails will not interfere later on with sawing the box at *C*.

Before the top and bottom are glued in place, cut ¼-in. pieces the width of the space between the top and bottom inside of the box (about 3½ in.) and just the length to fit snugly as indicated by dotted lines *D*. A drop or two of glue on the end wood will hold these pieces, which are to resist the pressure of the hand screws and prevent the sides and top from bending inwards.

Be sure the outside of the box is planed smooth, for rough and imperfect places will almost always show through thin veneer. As this article is primarily a discussion of veneering, the box itself can be left to the skill of the worker without further directions.

The veneers for the ends should be cut about ½ in. larger each way than the size of the box, as at *E*. Make straight, smooth cauls (blocks) of some soft wood about the size suggested at *F*. Provide pieces of folded newspaper to be placed between the veneer and the caul as at *G*; the paper will absorb moisture coming through the veneer from the glue. Set hand screws or clamps as at *H* ready for immediate use. Two may do but four will be better.

You are now ready for gluing. The room should be warm—at least 80° F., although 100° would be better. Heat the ends of the box, the veneer, and the cauls. Wax the latter with a piece of paraffin to prevent sticking.

Use rather thick glue of good grade, newly mixed and very hot. Equally important are the speed and skill of the worker. Spread the glue on one end of the box, not on the veneer; place the veneer on the glue, then add the paper and the caul. Turn the box to rest vertically on this caul and repeat the process on the other end.

Put the hand screws on without disturbing the cauls, and apply enough pressure to insure perfect contact. Too much pressure on such a small surface will force the glue out around the edges and "starve" the joint just where the greatest strength is needed. Another pair of hands to hold pieces in place, if you can get someone to help you, will simplify this process.

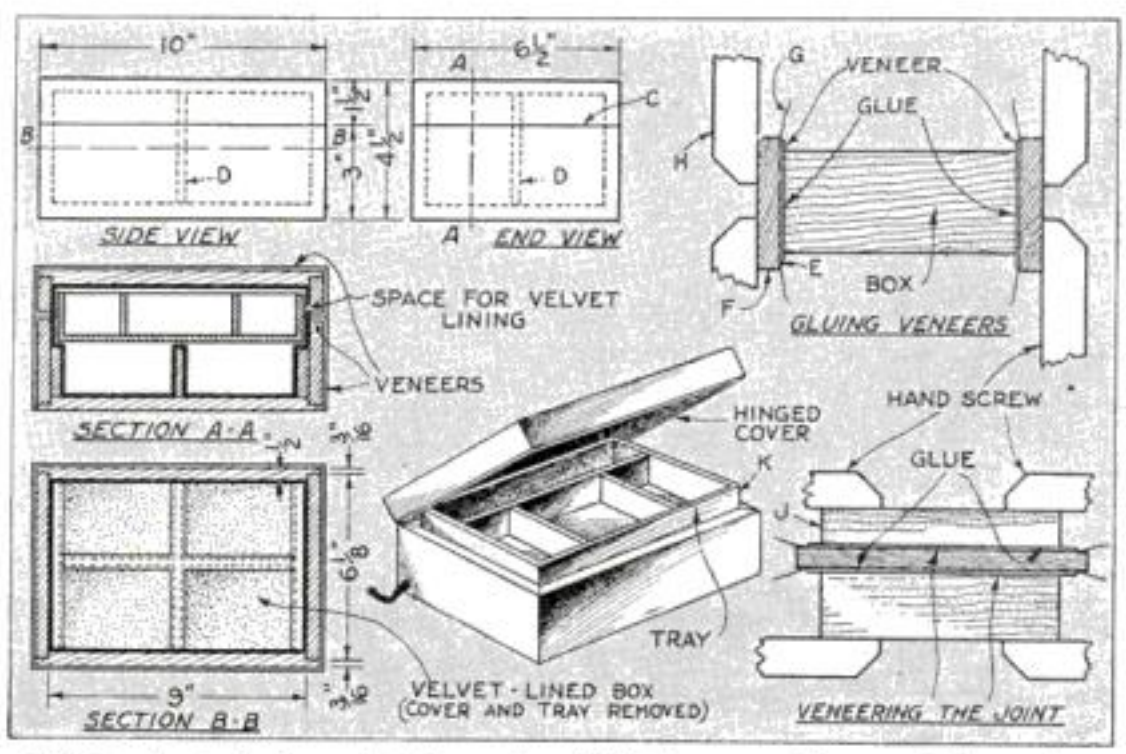
When the squeezed-out glue has hardened to a gummy texture, cut it away and save some trouble later on. Allow the box to remain at least twenty-four hours, and longer if possible. On a broad surface more time would be necessary.

Trim the veneer to the other surfaces of the box with the utmost care. Prepare veneer, paper, and cauls for the sides of the box and repeat the gluing process, using six hand screws if they are available, although four will answer the purpose if placed judiciously. Allow the same time for setting and repeat the process upon the top. No veneer will be needed on the bottom, although a piece of felt, glued on the last thing, will finish the bottom correctly.

Sandpaper all veneered surfaces. Round the corners slightly to prevent splintering, but not more than the thickness of the veneer.

With a sharp gage make an accurate line *C* 1½ in. from the top. Saw very carefully around the box and remove pieces *D*. With a perfectly conditioned plane, smooth the sawed edges, being sure that no splinters are broken from the veneers. Make the joint fit accurately.

(*Continued on page 137*)



This box is a typical example of veneering within the range of home workshop equipment. Note the use of paper *G*, blocks *F*, and hand screws *H* in the gluing process.

This is the Clayton & Lambert No. 70 fire-pot with tinner's hood. Produces a working flame in ninety seconds. Flame controlled as easily as a lamp. The burner orifice cannot be enlarged by tightening the needle valve. No chance of ruining the fire-pot that way—that's an exclusive C & L feature. Will heat a pair of soldering coppers and melt a pot of metal at the same time.

Always on its toes

A CLAYTON & LAMBERT won't cry for time out—it's always on its toes. Its solid construction and ingenious mechanism withstand rigorous, long-time use. You get years of service from a Clayton & Lambert—it's the product of constant improvement.

An example of that is the spider construction welded to the tank. It keeps the top structure properly aligned and firm. A Clayton & Lambert takes a mighty hard jar without being the worse for wear. And the multi-ribbed flame plate is another part almost indestructible. It's made to last a lifetime. If an extreme accident should occur—the plate is easily replaced.

The method of mixing air and gas vapor is a unique Clayton & Lambert feature. The proper proportions are always assured. And that, with the exclusive baffling-cup, gives *ninety seconds* starting. There's no "popping" or back-firing with a Clayton & Lambert. No matter how windy or draughty or unfavorable the conditions—your Clayton & Lambert performs just right! Certain types have a patented orifice that can't be enlarged by carelessness. Such exclusive improvements as those keep your Clayton & Lambert fit for action.

Be particular about your next fire-pot. Insist on a Clayton & Lambert. You can identify it by the bright red, protective band around the base of the tank. You'll be buying the most popular fire-pot in the world. Sold at nearly all hardware stores.

This is the Clayton & Lambert No. 60 fire-pot with plumber's shield. Tank capacity one gallon of gasoline. Burns six hours full capacity without refilling. The shield can be detached, and the handle locked, so that coppers can easily be heated.

CLAYTON & LAMBERT

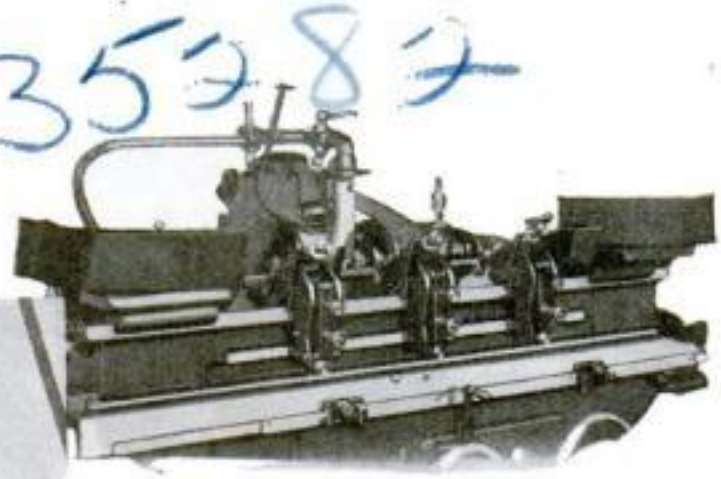
MANUFACTURING CO.
Detroit, Mich.

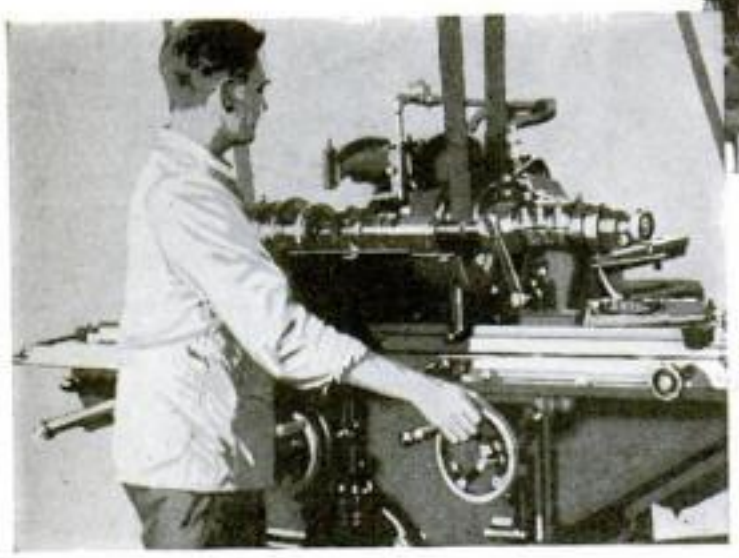
This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Cylindrical Grinding Helps

Care of Machine and Wheels—Centers—Use of Back Rests—Duplicate Pieces—Speeds and Feeds—Taper Work

By HECTOR J. CHAMBERLAND





Two grinding set-ups, the one above showing the use of universal back rests.

WHILE it is customary for the average tool room to employ a universal grinding machine operator, there are many small shops where the toolmaker or machinist is called upon to do his own grinding.

From all-around observations, I have found that many mechanics have very little knowledge of grinding operations, especially the older men. This is due to the fact that years ago the young apprentice was not given any grinding practice, as he always is today.

Cylindrical grinding, or, more correctly, external cylindrical grinding, has been such an important factor for many years in machine construction that every machinist should possess at least an elementary knowledge of this line of work.

Experience has shown that it is considerably cheaper to turn roughly and grind to size than to turn carefully and file to size; besides, a degree of accuracy and finish is obtained by grinding that is impossible to obtain with lathe and file. Nevertheless, we must bear in mind that for commercial reasons there is no such thing as absolute accuracy; certain limits of error must be accepted as inevitable.

A high degree of precision can be maintained only by giving the machine itself proper care. Oil is much cheaper than repairs and should be used freely. The machine should be wiped clean and treated with light oil every night or whenever it is to remain idle. All polished parts that are graduated should be kept covered with heavy oil. Enough soda or grinding compound should be used in the water to prevent the formation of rust, but too much may be injurious to the hands. Water should flow at the proper place on the work, as illustrated in Fig. 1.

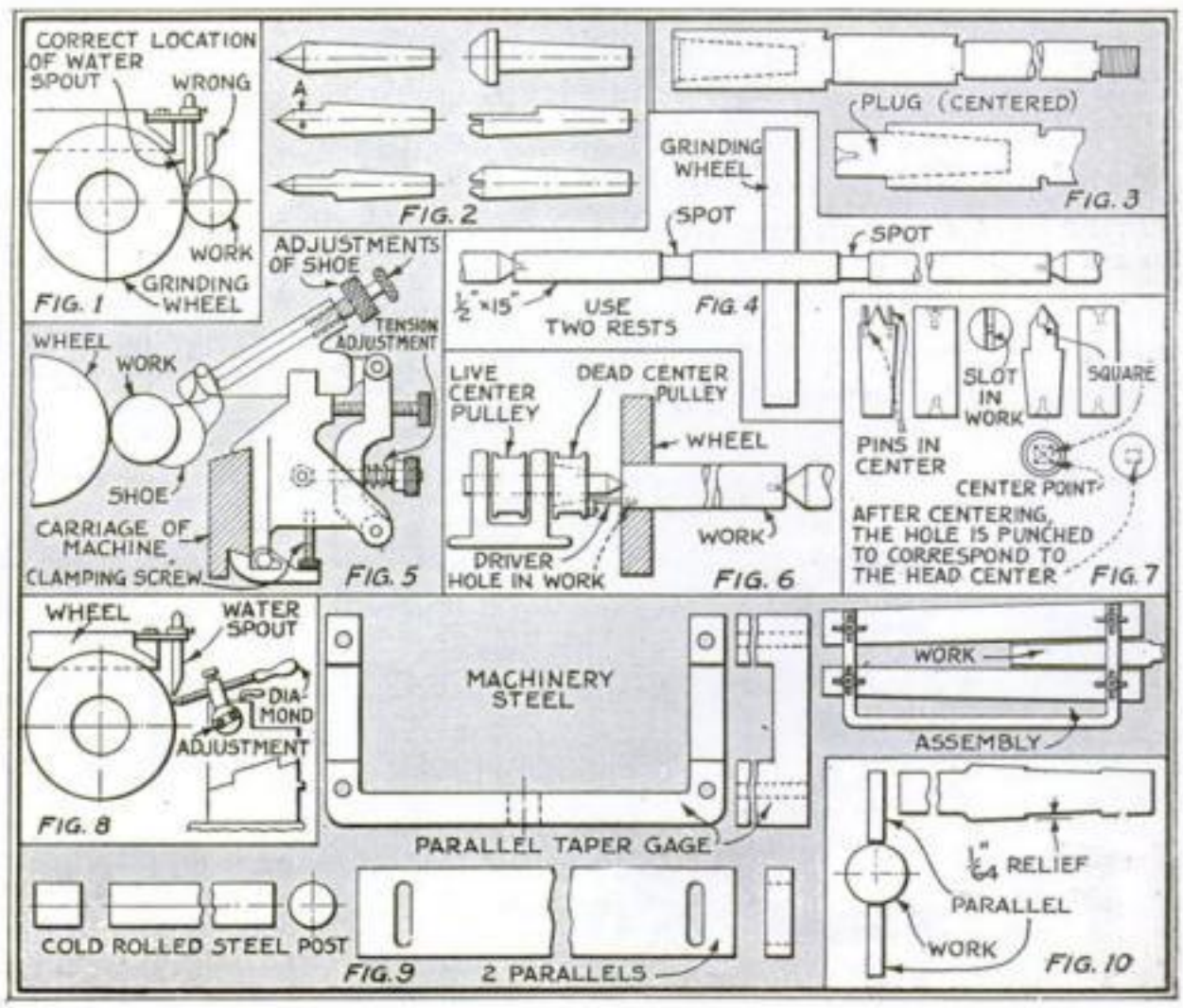
The cylindrical grinding machine was designed to give the finishing touch to the product of the lathe. The manufacturers spare nothing to incorporate the highest obtainable accuracy in every working part of the machine.

The wheel should be kept clean by dressing it as often as necessary and using water so as not to heat the diamond. The wheel also should be dressed each time it is set in motion, even if it has been stopped only for a few seconds, as the least play in the bearings would throw it more or less out of true. The bearings should be inspected often and adjusted when necessary to maintain accuracy.

The wheel slide or cross-feed mechanism should work freely. Oil its entire length daily. Too much attention cannot be given this last suggestion, for on this working part depends greatly the result of the grinding, as is clear when one considers that in feeding automatically crosswise, when the feed pawl advances the graduated ratchet one notch, the movement represents the removal of only one eighth of one thousandth inch of stock, or one quarter of one thousandth off the diameter, an amount invisible to the naked eye.

Work ground cylindrically is always held between dead centers. Occasionally, on universal grinding machines, certain jobs have to be done with a live head center, but in this case the center has to be ground in position before proceeding.

It is important in all cases that the centers be in good condition. The points must be free from wear and scratches and the angle should be exactly 60 degrees, to correspond to the center hole in the work. Figure 2 shows a set of centers generally used in (Continued on page 118)



Position of the water stream; centers for ordinary use and for grinding work in one cut; plugging large bores; back rest; diamond set-up for dressing wheels; and a shopmade taper gage.

They all KNOW the *meaning* of Starrett Quality

"Every building or carpentry job is the better for Starrett accuracy."

"Expert machinists and auto repair men will tell you it pays to stick to Starrett's."

"I use tools for pleasure in my home shop. That's why I buy only the finest—like Starrett's."

EVERY man who uses tools is able to appreciate at first hand the genuine satisfaction as well as true economy of tools built to Starrett standards of materials and workmanship. For there are more than 2500 Starrett Tools, Tapes and Hacksaws, every one of them made to give more than a full measure of accurate, dependable service.

Your tool dealer has them. Be sure to ask him for Starretts and look for the name or "The L. S. S. Co." on every tool. Ask us to send you a free copy of the great Starrett Catalog No. 24 "W".

THE L. S. STARRETT CO.
World's Greatest Toolmakers
Manufacturers of Hacksaws Unexcelled
Steel Tapes—Standard for Accuracy
ATHOL, MASS., U. S. A.

"Out on road or construction jobs Starrett Tapes and Transits give us lasting satisfaction."

Ⓢ

STARRETT TOOLS — STARRETT HACK SAWS CUT QUICKER LAST LONGER — STARRETT TAPES STANDARD FOR ACCURACY

Use Starrett Tools

Ⓢ This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Dodging Errors in Shop Work

How to Avoid Clamping Strains That Cause Distortion—Little Known Points on Using Paper Under Machine Set-Ups

By HENRY SIMON

PERPLEXING errors in the machine shop sometimes are due to mechanical distortion within the work. Unlike the disalignment troubles described in the February issue, which are generally confined to the lathe and lathe-type machines, these new strains are common also with other machine tools such as millers, shapers, and grinders. It will, however, be sufficient to deal with the subject in connection with the lathe.

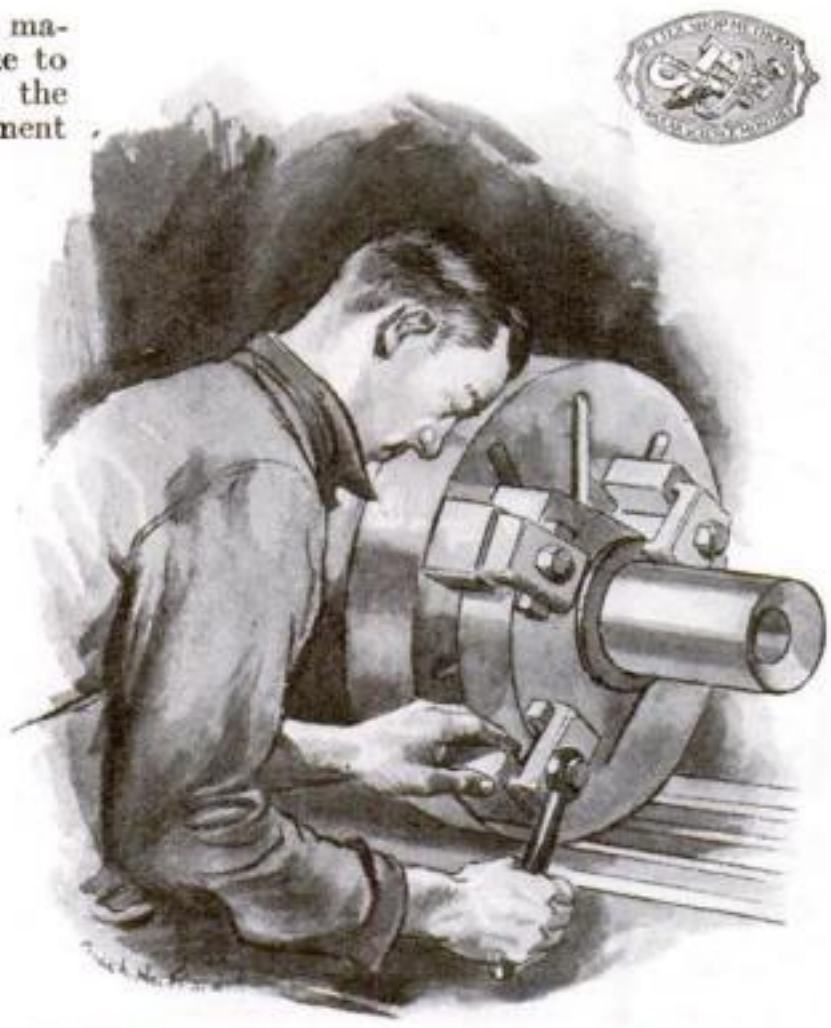
Paper used as friction material under the work is in bad repute with some mechanics because of its alleged trouble-making tendencies. It is well to remember that paper should never be used under the registering surfaces of precision work, but this is no reason for doing without its help where only ordinary accuracy is demanded.

A great deal depends upon a proper choice of the paper, and it is here that many mistakes are made. Some mechanics seem to think that to do any good, the paper must be strong, and that to be strong, it must be heavy. This is a case of a right idea wrongly applied. The paper should preferably be tough and above all hard, but it should be as thin as possible.

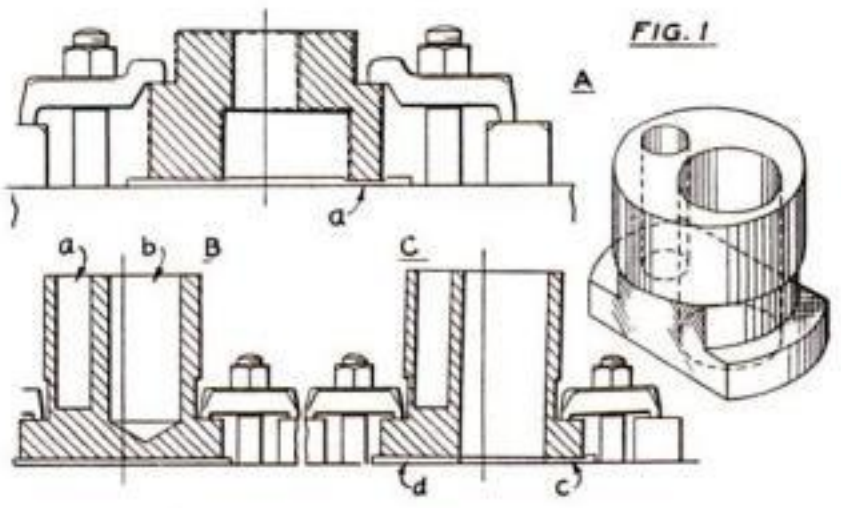
A common consequence of using a thick paper is seen in Fig. 1 at *A*. The most serious form of this trouble occurs through progressive disalignment during work. Under the vibration of cutting the paper gradually becomes further compressed, so that the work is out of alignment by the time it is finished.

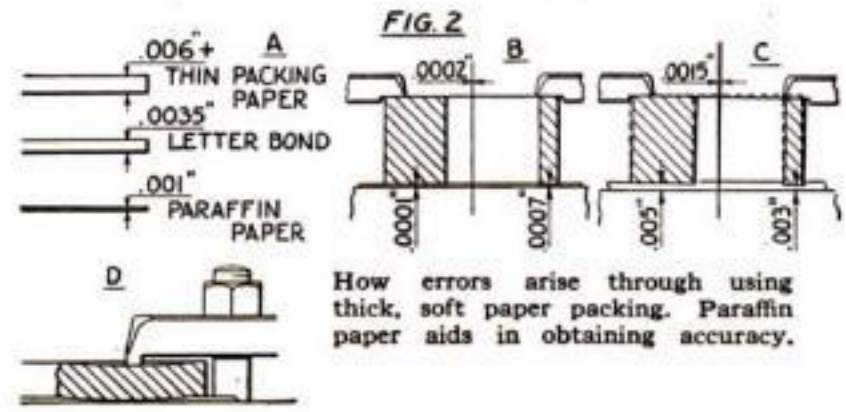
A TREACHEROUS condition is that shown at *B* and *C*. The bore *a* in the part was lined up true at the start. The moment the eccentric bore *b* was put through and a large portion of the paper underneath cut out, the doubled pressure coming on the area *c* compressed the paper more than at *d*. If the part were finished in this condition, the second bore would be "off" as shown.

Troubles of this kind are common when packing paper or newspaper is used. An ordinary letter bond is better, though even this should be used only where the clamped surface is fairly large. The ideal material for finer work is one of the better grades of paraffin paper. These papers are tough, hard finished, and many of them less than one third the thickness of average letter paper, as may be seen from the graphic comparison at *A*, Fig. 2.



When clamps might distort thin undercut parts, blocking can be placed so as to transmit the pressure to the solid metal.





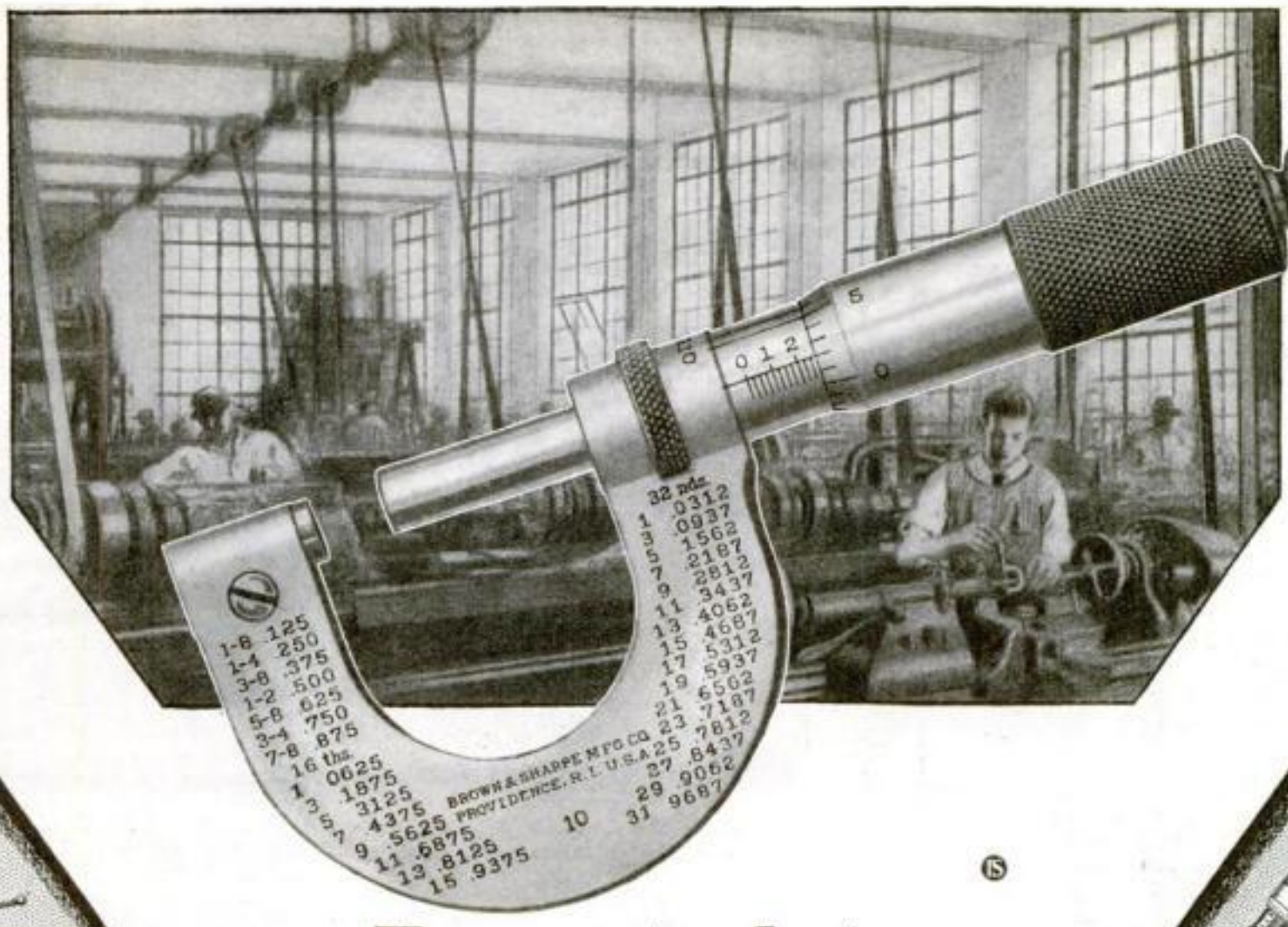
How errors arise through using thick, soft paper packing. Paraffin paper aids in obtaining accuracy.

Even a thin and hard paper may, of course, become unevenly compressed, but there is a big difference between a fairly soft material of .005 in. thickness that can be compressed readily to .003 in. and a hard-finished paper .001 in. thick which the same pressure will reduce only to .0007 in. The variation of three ten-thousandths in the thickness of the part at *B* and the resulting slight difference in the bore will probably be of no consequence, while the deviations of .002 in. in thickness and .0015 in. in diameter resulting with a thick paper under the same part at *C* are likely to be altogether excessive.

CAUTION is always necessary when paper is used underneath work of which the clamped portions are very thin, in order to avoid the condition shown exaggerated at *D*. Such work cannot be clamped as hard as if it were against the metal surface of the machine table. On the other hand, it should be remembered that paper between two metal surfaces reduces the force necessary for holding them against slippage from a third to a half, and so can be made to prevent deformation by reducing the required pressure.

From surfaces which yield under pressure because a softer material is under them to surfaces which yield because nothing is under them is but a step. It may seem needless to point out that undercut parts should be clamped so that the pressure will be transmitted straight through to the table surface as at *A*, Fig. 3, instead of indirectly as at *B*. Although the principle is well recognized, it is often violated in practice.

Trouble from this source is especially likely where work must be reset for finishing two surfaces in succession. With the dial test indicator at our command, we may feel too sure of our ability to get out of any "hole." Though the part shown at *A*, Fig. 4, for instance, is in fact improperly clamped, parallelism between the outside diameter and the eccentric bore is obtained by reclamping the part as at *B* so as to reproduce the same error in finishing diameter *b*, and (Continued on page 116)



Essential to Modern Methods

Caliper
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Micrometer
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No. 705

Modern factory methods step up the output of men and machines. One machine today does the work formerly done by many. One man does a job that used to require several. But the need for accuracy never diminishes. Rather it increases with the increased speed of production.

That is why in modern machine shops you will find more and more precision instruments—such as the Micrometer illustrated above. And the general preference shown for Brown & Sharpe measuring tools is industry's way of saying that no finer guarantee of accuracy can be obtained.

Ask for a free copy of Catalog No. 30 listing over 2300 Brown & Sharpe Tools, including Micrometer Caliper No. 10 RS (range 0 to 1″ by ten thousandths of an inch) shown above. At your hardware dealer or from us direct. Dept. P. S., Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.

B·S

"World's Standard of Accuracy"

BROWN & SHARPE TOOLS

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Finishing *Our* River Packet

La Belle Riviere in the film version of *Uncle Tom's Cabin*. Originally the *Kate Adams*, she was constructed by the builders of the *Buckeye State*.

By

E. ARMITAGE MCCANN
Master Mariner

ONLY the stern wheel, the pilot house, and a few other details remain to be completed on our model of the famous old Mississippi steamboat, the *Buckeye State*.

Readers who have not seen the four preceding installments, yet would like to start building the model at this time, can do so by obtaining POPULAR SCIENCE MONTHLY Blueprints Nos. 94, 95, and 96, which contain complete full size drawings (see page 108). Copies of the November, December, January, and February issues of the magazine also can be obtained for twenty-five cents each.

Any builders of the model who have not yet read Mark Twain's *Life on the Mississippi* should do so at once, for it will be a genuine treat. Those who read it in years past will find, in the light of their new knowledge of Mississippi steamboats, a keener delight in rereading it. And if those who have hesitated about undertaking the construction of this model will only read that fascinating story of adventure and romance on the Great River, they too will be eager to construct the *Buckeye State*.

Our next job is to make the stern wheel. By referring to the illustration on page 98 it will be seen that there are three wheel-like members with radial arms or spokes. On the ship itself there were five, but on so small a model it seemed that two could be omitted. On a larger model it would be well to use five. There are fifteen arms with flanges which hold the fifteen paddles in position. While I made the whole wheel of metal soldered into one unit, it would be possible with a little more trouble to make the paddles of wood, and that would give a better effect.

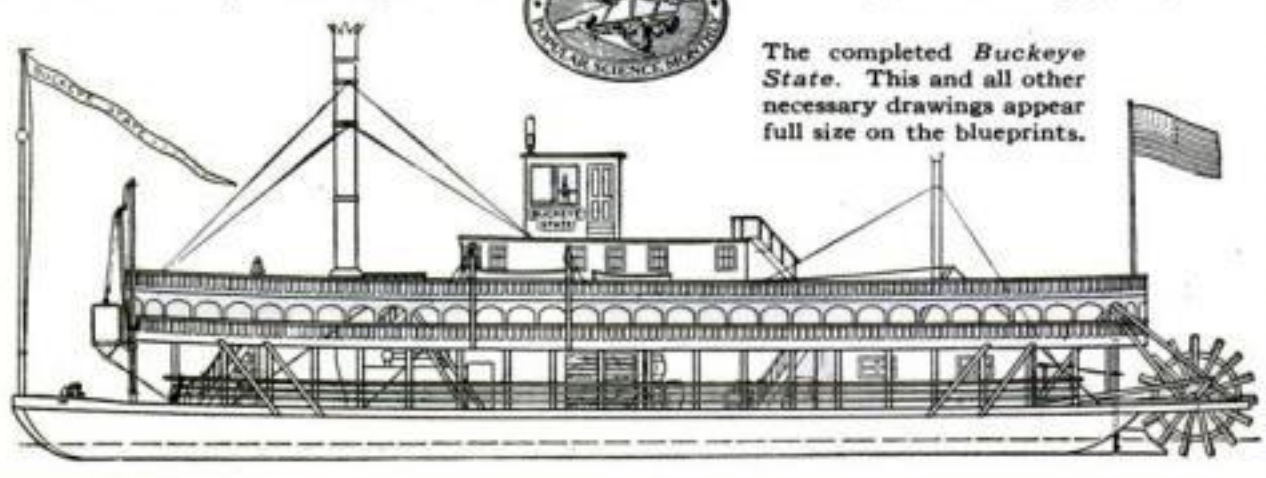
First make a crank shaft as shown from wire or rod not less than 3/32 in. in diameter. After bending the cranks, file them flat so that they will work in the slots in the deck. Bore holes in the ends of the cranks. Small notches will have to be filed in the supporting timbers.

From sheet tin, brass, or copper, cut three sets of flanges and arms. In laying out these pieces follow the full size pattern on Blueprint No. 96. The extra width of the arms at their ends is bent over sharply to provide surfaces against which to solder or bolt the paddles.

Cut the three circular bands or braces so that they can be soldered on the arms just inside the flanges for the paddles.

Punch holes to receive the crank shaft and solder the wheels in place, taking care that the flanges of the outer wheels turn inward and that the arms are so arranged that the paddles

(*Continued on page 98*)



The completed *Buckeye State*. This and all other necessary drawings appear full size on the blueprints.

For the handy man—You, for instance!

Kyanize

FLOOR FINISH

Dry-In-Four-Hours

Here is the new dry-in-four-hours varnish stain which squarely meets the demand for a quick drying finish ready for immediate use on furniture, woodwork or floors. It is a varnish and color combined, ranging from Light Oak to Dark Mahogany. Also Clear. No matter how little you've handled brush or sprayer, KYANIZE will give the desired results without fuss or bother. No offensive odor.

For Old Floors

Kyanize

u can easily make an old hard wood like new.
ıply brush on a coat of KYANIZE Floor —it's easy to apply—dries in four hours ng a bright lustrous surface that is solutely waterproof and can't scratch ite. Great for linoleums and beautifies the n or grain.

For Old or New Furniture

Kyanize

Because it is so easy to apply—so tough and durable—so waterproof, and produces such a smooth and beautiful transparent finish—KYANIZE Floor Finish is just ideal for furniture.

Brushes on easily. Transparent and shows the grain or pattern beautifully.

On wicker or reed furniture KYANIZE Finishes may be easily brushed or sprayed with satisfactory results.

or our new booklet, "The Charm of Painted Things," or if your dealer cannot supply with KYANIZE, send $1.00 for a special trial pint can with brush and booklet included.

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Covers easily and quickly. Waterproof, sanitary and dries quickly. No offensive odor. Twelve colorful tints. For re-finishing new or old furniture, walls or woodwork.

Finishing Our River Packet

(Continued from page 96)

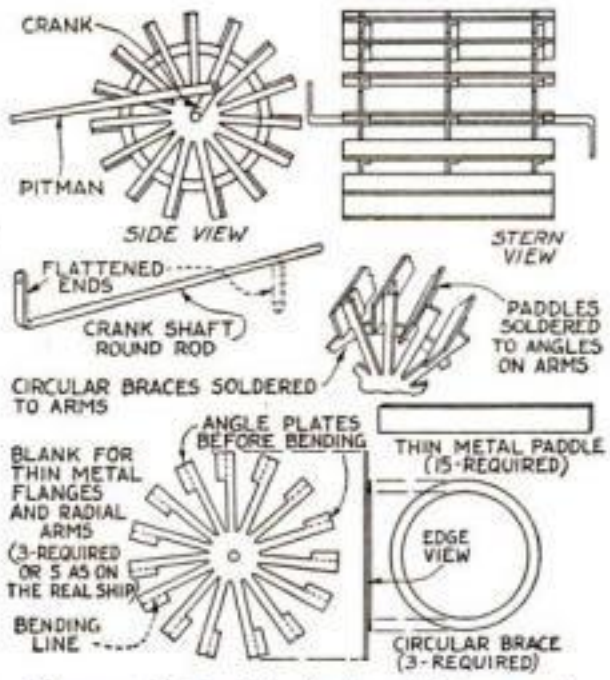
will lie straight across, each supported at three points.

If the paddles are to be wood, drill holes in the flanges and rivet the paddles on with small pins; if of metal, solder them. The paddles should be below the radial arms when descending into the water on the forward revolution.

Rivet the connecting rods or pitmen to the cranks. Have the pitmen of sufficient length so that they will not slip out of the slots in the engine room when the cranks are at the extremity of their stroke aft.

Paint the metal parts of the wheel a rusty black, and the paddles a dark wood color. Fix the stern wheel in position by nailing strips of metal over the shaft with pins, the points of which should be turned up underneath. The wheel should turn clear of the rudders and extend almost to the line of the hull bottom.

Fasten a block of wood ⅞ by 1¼ by 1⅜ in. over all, shaped and slotted as shown in the next column, to serve as the base of the pilot house. The steering wheel turns partly in the slot of this block and is supported by two standards cut from sheet metal. One is fastened to the forward face of the slot and the other is set into the surface of the block. Between them is the barrel to take the wheel ropes. The ends of the ropes are merely fastened in these holes unless it is desired to have the rudder turn. In that case a large hole can be bored right through the model to meet the



The assembled paddle wheel and pitman, and details of its parts and of the crank shaft.

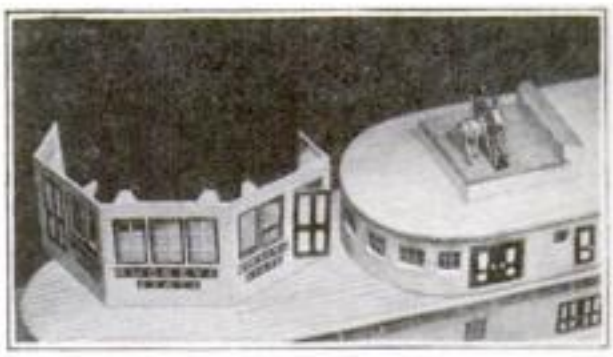
two small holes, and the ropes can be led through staples under the boiler deck to the tiller.

The wheel itself can be made or purchased. Its size, as invariably the case with this type of boat, was very large. A big wheel was necessary to give the advantage of long leverage for making quick, short turns in a strong river current.

Construct the pilot house walls from cardboard and transparent celluloid as previously described. The side windows and the doors may well be open. Three steps will be required to lead to the doors.

The deck above the pilot house will be similar to the others and project a full ⅛ in. Insert into it one or two steam whistles made from brass rod or gilded wood. Another ladder will be required to lead from the stateroom deck to the top of the texas as shown on page 96.

Incidentally, the term "stateroom" originated with these boats. Each room had the



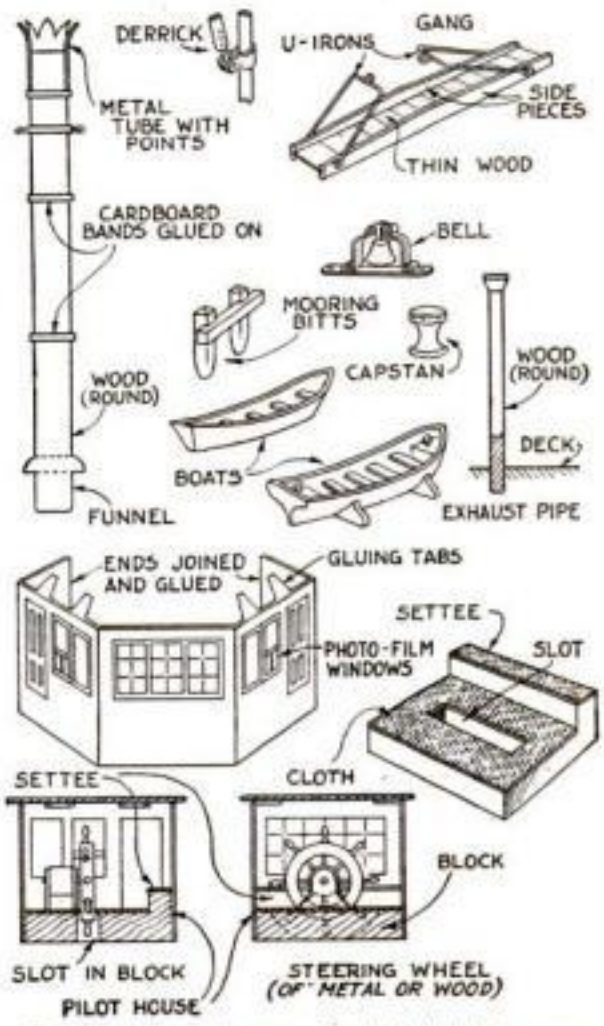
Pilot house block with the steering wheel in place, and the cardboard walls ready to be set up.

name of a state on the door and was therefore called a stateroom. The texas had no state name and was the officers' and pilots' quarters. Texas, the Lone Star State, was, at the time the name originated, an appendage to the United States as the officers' cabins were an appendage or addition to the steamboats. It may have been for this or some similar reason the name texas was used for the officers' quarters.

The funnels are of wood capped with tin or copper tubes in which cuts have been made and the points bent out. The bands are cardboard strips, and the lower flange rings of wood. The central ornament (Blueprint No. 96) is cut from sheet metal or celluloid (such as a piece from a cheapcomb) and is gilded. The guys are of the thinnest obtainable wire fastened to staples in the sides of the funnels and to others in the deck. The exhaust steam pipes are of wood or metal tubing expanded at the ends. They have similar guys.

The bell, a full ¼ in. in diameter, can be turned of brass or purchased. It saves considerable work to buy both the bell and the steering wheel ready-made.

Little provision was made on old river boats for small boats. The *Buckeye State* had crude davits and, so far as I could learn, boats somewhat like those shown below. However, the typical river type of small boat is the so-called Ohio skiff, built from four wide cypress boards with (Continued on page 114)



Details of funnels, gangplank, bell, bitts, capstan, boats, exhaust pipe, derrick, pilot house.

How to Make a Magic Funnel

It Contains a Hidden Space for Liquids and Is Used in the Trick of Pumping Water from a Boy

By GEORGE S. GREENE

35141

MAGIC apparatus of professional quality can be constructed quite easily at home. It can be used for parlor performances, for giving vaudeville numbers between acts at amateur theatricals, or on the stage in a special magician's act.

After building the magic funnel shown in the accompanying illustrations and other apparatus to be described in coming issues, you will have at your disposal a repertoire of magical illusions.

The rim is cut from one funnel; a narrow piece and the spout are cut from the other.

A small hole is punched near the rim of the inner funnel for controlling the flow.

One funnel is fitted within the other; the two are soldered at the rim.

In announcing the funnel trick, the performer says that he will "turn a glass of water into a boy." A juvenile member of the audience is inveigled into drinking a glass of water. The performer then announces that he will pump the water from the lad's elbow. While he holds an ordinary looking funnel under one of the boy's elbows, an assistant uses the other arm of the boy as if it were a pump handle. Water is seen to stream from the funnel into a glass held below him. Milk, "wine," or any other liquid may be produced with equal success.

The entire effect depends on the way the funnel is trickled. Buy two similar tinned funnels and treat one as follows:

Remove the lower part and discard it. Make the upper part, which is the horn-shaped piece, smaller by cutting out part of it and soldering the joint, so that while the funnel is then the same size as it originally was at the top or rim, the lower part is of considerably less circumference. When this reduced part is placed inside the other funnel there will be a space of some size between the walls. Punch a small hole near the rim.

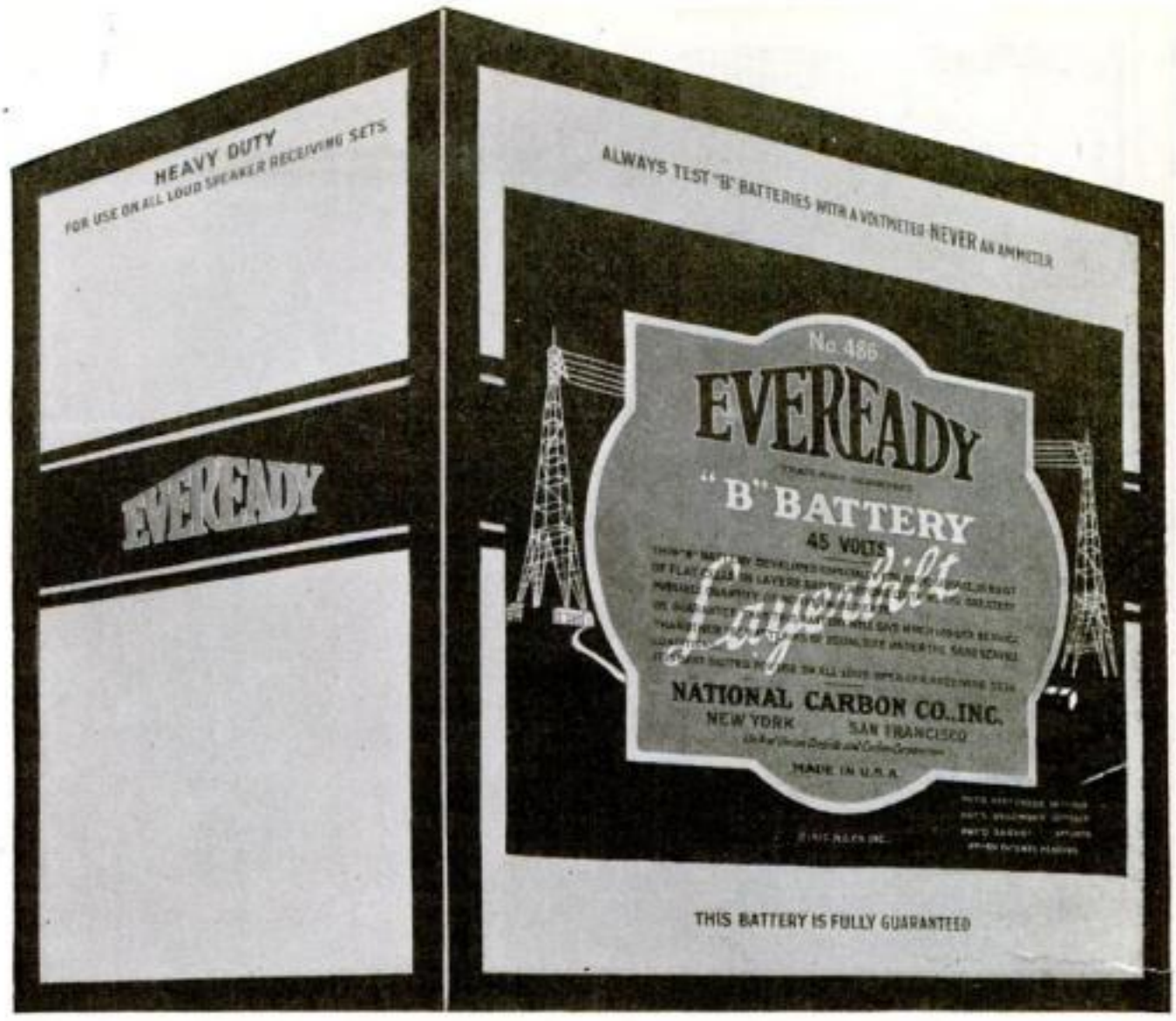
To prepare the second funnel, merely trim off the top rim with tin snips. Fit the small funnel within it and solder the two parts securely at the rim, polishing the solder so that it will not show. Be sure the joint is absolutely air-tight.

Immediately before the performance, the prepared funnel is placed in a pail of water. The inner compartment, holding about a glass of water, will then fill. When the funnel is removed from the water, a bit of wax is affixed to the hole near the rim.

The wax is removed when it is desired that the water leave the funnel. Most performers control the small hole with the thumb by using an on and off movement so that the water will run and stop at intervals to correspond with the pumping motion enacted by the assistant who is working the "subject's" other arm up and down.

Care must be taken to do the soldering around the rim so the joint will be air-tight.

This is the first of a series of articles on the construction of magic apparatus for amateur entertainments. The next, on turning a handkerchief into an egg, will be in an early issue.



This is the original LARGE SIZE Eveready Layerbilt No. 486 for heavy duty—list price, $4.25, only 25 cents more than the Eveready cylindrical cell battery of the same size, No. 770. There is another Eveready Layerbilt in Medium Size No. 485—list price, $2.95, only 20 cents more than the Eveready cylindrical cell "B" battery No. 772.

Diagram illustrating the simplicity of the Eveready Layerbilt construction. Only two broad metal bands and only five soldered connections. No waste spaces. It's all battery. Note the contrast between this construction and that illustrated below.

THE EVEREADY LAYERBILT IS THE ONLY "B" BATTERY BUILT WITHOUT FINE CONNECTING WIRES AND MANY SOLDERED POINTS

THE next time you buy "B" batteries, get Eveready Layerbilts. These famous batteries now have had three years of public use, and the public has found them to be what we have always said they were—the best, the most satisfactory, the most economical and the longest lasting of all "B" batteries.

The reason Eveready Layerbilts are all those things is a simple one—they are built of flat cells. Those cells pack together tightly, occupying all available space inside the battery box. They make connection with each other automatically, minimizing soldered connections. In a 45-volt, cylindrical cell "B" battery there are 30 individual cells, each with two soldered points, making 60 solderings. In addition, there are 29 small wires to connect these points—89 chances for trouble!

In the Eveready Layerbilt, however, there are but five soldered connections. Instead of a maze of fine wires, there are only two thick metal bands, each 3/8 inch wide. All other connections are made automatically, by contact of the full surface of one flat cell against its neighbors.

All these things make a better battery, a battery that is more reliable, more satisfactory and longer lasting. The Eveready Layerbilt is made in two sizes, Medium and Large Size. Either costs you only a few cents more than the cylindrical cell Eveready of the same size, and will last from 25% to 30% longer. When you buy "B" batteries, get Eveready Layerbilts. The longest lasting and most economical is the Large Size Eveready Layerbilt No. 486. Look for the name "Layerbilt" on the label.

Diagram illustrating the construction of a cylindrical cell "B" battery. Two solderings per cell, or 60 in all, and 29 fine wires—89 chances for trouble. Note waste spaces between cells.

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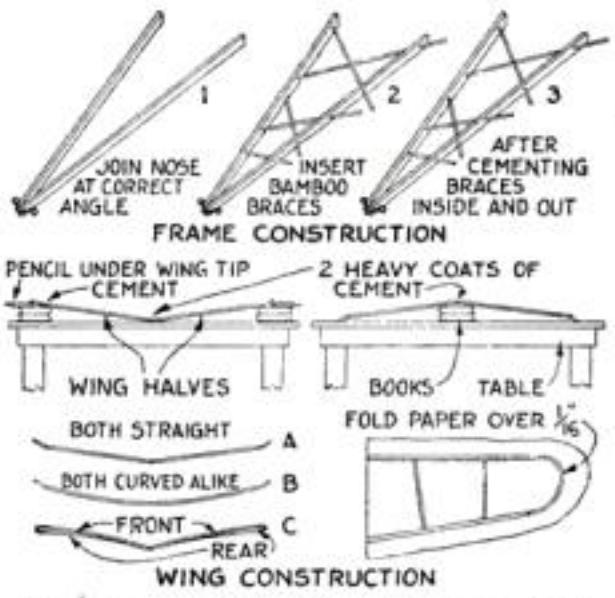
TUESDAY NIGHT IS EVEREADY HOUR NIGHT. *East of the Rockies*—9 P. M. Eastern Standard Time, through WEAF and associated N. B. C. stations. *On the Pacific Coast*—8 P. M. Pacific Standard Time, through N. B. C. Pacific Coast network.

SEE AND HEAR THE NEW EVEREADY RADIO SETS

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

This Model Broke All Records

(Continued from page 79)



Steps in assembling frame and wings. Note that the wings must be alike on both sides, but can have any one of three different shapes.

from the front and slide the bamboo projections in or out. Again check the space at the rear. When the kinks have been practically eliminated, cement the inside junction of the beams with the bamboo.

When the cement is dry, carefully split off the pieces of bamboo projecting beyond the frame, only a small sliver at a time. Cement where the X-braces cross as well as the outside surface of the spars where the bamboo comes flush with the surface. Also cement the inside junctions again, especially the rear X-braces.

Insert and cement the cans. See that they line up fairly well by sighting through them.

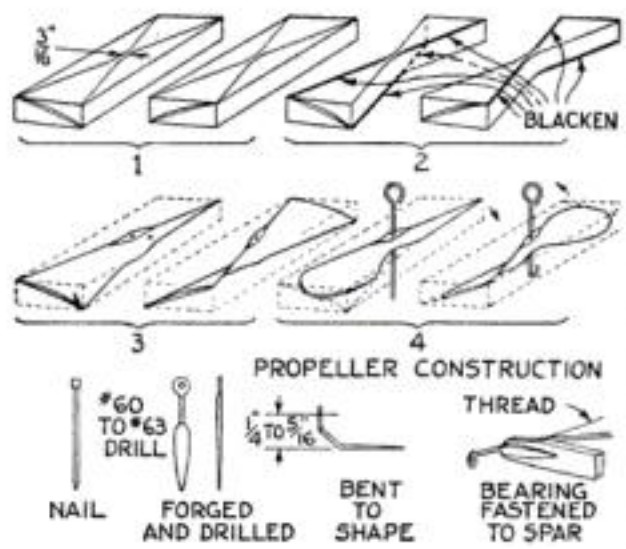
Cement on the bearings at the rear of the frame. Use two coats, and, as an added precaution when the cement is dry, carry a string of wet cement around the motor stick and bearing at the point where the bearing bends. Many a model flyer has been disappointed at a contest because a bearing has come loose.

Morris found it necessary to tie double strands of size D buttonhole-twist silk thread across the rear X-bracing as shown. This silk thread should be tied up close to the motor base spars to prevent slipping and should be cemented securely. It should be doped with a coat of paper cement.

Make the two elevator tips; their actual size is shown on Blueprint No. 102. Cut a notch $\frac{3}{8}$ in. long to fit the bamboo elevator beams. The beams are streamlined and tapered from $\frac{1}{16}$ by $\frac{5}{64}$ in. at the center to $\frac{3}{64}$ by $\frac{1}{16}$ in. at the tips. Make a full size drawing of the elevator on a piece of corrugated cardboard and pin the parts in place or hold them with weights while the joints are being cemented in the same manner as the wing was assembled.

Turn the elevator over and recement the bottom side at the joints, but be careful not to put on too much, as it might loosen the cement on the top. The bends can be put into the elevator beams over a very hot rod or soldering iron. Be sure that you have the greater angle in the front beam. Dope the elevator framework with paper cement and paper it like the wing.

The propellers are standard true-pitch style. Mark the blanks *C* with diagonal lines from



How the propellers are marked and carved and the bearings are made from small nails.

corner to corner on the wide faces; use a very sharp, hard pencil. Locate the center by measurement; the point where the lines cross often is not exactly in the center. Draw two lines $\frac{3}{32}$ in. on each side of the center and parallel with the edges of the block to locate the hub. Then draw diagonal lines in opposite directions on each end of each blank.

Cut the blanks as shown above, blacken the edges so that you will not overstep your mark in carving, and carve them.

In carving, work closely to the blackened lines but do not cut into them at all. Then sandpaper the blades down so that they are almost $\frac{1}{32}$ in. thick at the tips and taper gradually to about $\frac{1}{16}$ in. at the middle and about $\frac{3}{32}$ in. close to the hub. The hub should be about $\frac{5}{32}$ in. thick. The bottom or rear of the blade should be flat, while the top or front should be slightly rounded. Do not cut or camber the propeller blade very much on the bottom side. Be sure that one propeller is left-handed and the other right-handed.

Round the tips and thin the edges, using a pattern to get all four tips exactly alike. Balance the blades at the center on a knife edge and sandpaper the heavy end. Then cut away some of the surplus wood at the back of the hub and sandpaper the cut edges smooth.

Bend the shafts from No. 14 music wire $3\frac{1}{8}$ in. long. No drilling (Continued on page 106)

Materials for the Model

A 2 pcs. $\frac{1}{16}$ by $\frac{3}{8}$ by 40 in. balsa for motor bases.
B 4 pcs. $\frac{1}{16}$ by $\frac{1}{4}$ by 14 in. balsa for wing beams.
C 2 pcs. $\frac{5}{16}$ by $1\frac{1}{4}$ by 12 in. balsa for propellers.
D 2 pcs. $\frac{1}{16}$ by 1 by $2\frac{3}{4}$ in. balsa veneer for front float formers.
E 1 pc. $\frac{1}{16}$ by $1\frac{1}{4}$ by $3\frac{1}{2}$ in. balsa veneer for rear float.
F 2 pcs. $3\frac{1}{2}$ by 1 by $\frac{1}{16}$ in. balsa for elevator tips.
G 3 pcs. 15 in. long bamboo for rear X-braces, front frame braces, ribs, elevator, and float struts.
H 2 pcs. bamboo for curved parts, as shown in drawings.
I 2 light steel thrust bearings.
J 4 light airplane model washers, hard brass.
K 1 pc. No. 14 (.033 in. dia.) music wire, 24 in. long.
L 1 pc. No. 11 (.026 in. dia.) music wire, 24 in. long.
M 1 pc. No. 6 (.016 in. dia.) music wire, 12 in. long.
N 2 pcs. $\frac{1}{2}$ by $\frac{1}{8}$ in. rubber motors—33-ft. strip.
O 1 pc. small spaghetti tube (electrical insulation) for sockets.
P 1 pc. 21 by 31 in. Japanese tissue paper.
Q 1 2-oz. can of ambroid type cement.
R 1 1-oz. bottle of hydro dope.
S 1 2-oz. bottle of light dope.
T 1 1-oz. bottle of paper cement.
U Heavy silk thread, size D buttonhole twist.

No. 414—Standard weighs 5½ lbs. Capacity ¼" in steel. Complete with 8' of best grade rubber-covered cord and plug. **$30.00**

Drilling is only *one* thing this POWER tool *does*

DRILLING metal or wood is only one of many jobs you can handle easily with this Millers Falls Standard Drill.

ounce of needless weight. You'll best appreciate this when you're "drilling *up*"—or working on the underside of your car.

Buffing or polishing the nickel work of your car takes seconds instead of half an hour or more. A wire scratch brush slipped into the chuck will remove old paint while your arm would just be beginning to ache by the sandpaper method.

Carbon to come out of your car? Instead of digging with the old putty knife, get a wire end brush busy at 1000 R. P. M. or better. You'll get a swift job and cleaner and more thorough than you thought possible.

Hard work that takes it out of your shoulders is plain fun for this power tool. In it ventilation has been so perfected that overheating is a stranger.

This Millers Falls Drill hasn't an

You can buy this drill separately — or as part of the Millers Falls Electric Toolshop. This Toolshop includes 21 separate attachments for drilling, cutting, sawing, sanding, polishing and grinding. It's fine for repairing — and "making things".

BUT—it's more interesting to TRY this good tool than just to read about it. Write us, and we'll tell you where you can handle it yourself —and enjoy the thrill of "guiding it through".

The Price? Much less than you thought for such quality—The Portable Drill, $30.00—The Electric Toolshop, including the Drill, $68.00. Saw Table, $10.00 Extra.

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Painting Basement Walls

How to Give Them an Attractive, Durable Finish at the Lowest Cost

By BERTON ELLIOT

"WHAT shall I use for painting the basement walls?" asked a friend of mine the other day.

"There's only one kind of material I would use for painting basement walls," I told him. "That's cold water paint."

I explained that I was speaking of the typical basement or cellar with a furnace in the middle of the floor, and laundry tubs, a washing machine, and perhaps a workbench in the corner—a reg'lar basement, and not one of the nicely finished and furnished basement rooms one sometimes sees. He assured me that his was an ordinary, everyday basement.

"Yes, cold water paint is one of the most satisfactory and economical materials you can use," I continued. But I noticed a puzzled look on his face, as if he didn't entirely comprehend what I was talking about. "Guess you aren't sure you know just what cold water paint is. A good many people don't, or have a wrong conception of it. I'll tell you all about it.

"In the first place, cold water paint is not calcimine, although calcimine is mixed with water. Calcimine is not satisfactory for use on basement walls where there is the least bit of dampness or moisture, for it is made with a glue binder, and when it gets wet it runs—and you have a terrible mess. Of course, if the basement is thoroughly dry all the year through, and no water gets on the walls from the weekly wash or from cleaning the floors, calcimine will be entirely satisfactory, as it adheres well to any kind of surface—concrete, brick, or wood. So much for calcimine."

Then I pointed out that cold water paint is entirely different from the old-time whitewash made with lime and water, which used to be the popular coating for basement surfaces, whenever they were painted at all. Whitewash is a temporary finish. It has nothing to hold it together and soon disintegrates and scales off; before long it begins to look very unsightly.

Cold water paint is a distinct type; most paint stores sell it and any of them can get it for you. A dry powder, it has to be mixed with water immediately before use. It is made with a special type of binder that has the property of absorbing and taking up water and giving it off again, so that when wet it dries out to its original condition without running or discoloration.

"I don't mean that this is better than the oil paints and concrete wall finishes," I hastened to warn my friend. "If you have a *de luxe* basement room where the finest finish is wanted—or if money is no particular object—the oil paints and concrete finishes are among the highest types of finish obtainable. However, my idea of a paint for the walls of the average basement is one that will answer the purpose with thorough satisfaction and at the same time not cost much.

One coat of cold water paint makes an excellent and inexpensive basement finish.

"Cold water paint is cheap. For a dollar or two—and a lot of free water—you can do the whole basement. It is durable, stands being wet, and covers well; one coat produces a fine job. You can turn the hose on it, and it will dry out nicely. It can be used on wood surfaces as well as concrete, cement, brick, or stone. When you want to repaint, you can cover over it, while with calcimine, for instance, it is hard to do a satisfactory job of refinishing without removing the old coating. Cold water paint is usually made in white only, but it may be tinted as desired with dry colors, sold by most paint stores for tinting purposes."

"That's good," exclaimed my listener at this point, "for I had in mind a gray. Don't believe I could get the wife to have any other color."

"Well, here's the way to make a good French gray: Mix some raw umber and just a little lampblack with your white cold water paint—say about a quarter pound of the raw umber to five pounds of white paint. You can start with a small amount of the tinting color and add slowly until you get just the shade you want. Or if you'd rather have more of a steel gray, use lampblack instead of raw umber—probably a little less than a quarter of a pound will do—and add just a touch of ultramarine blue.

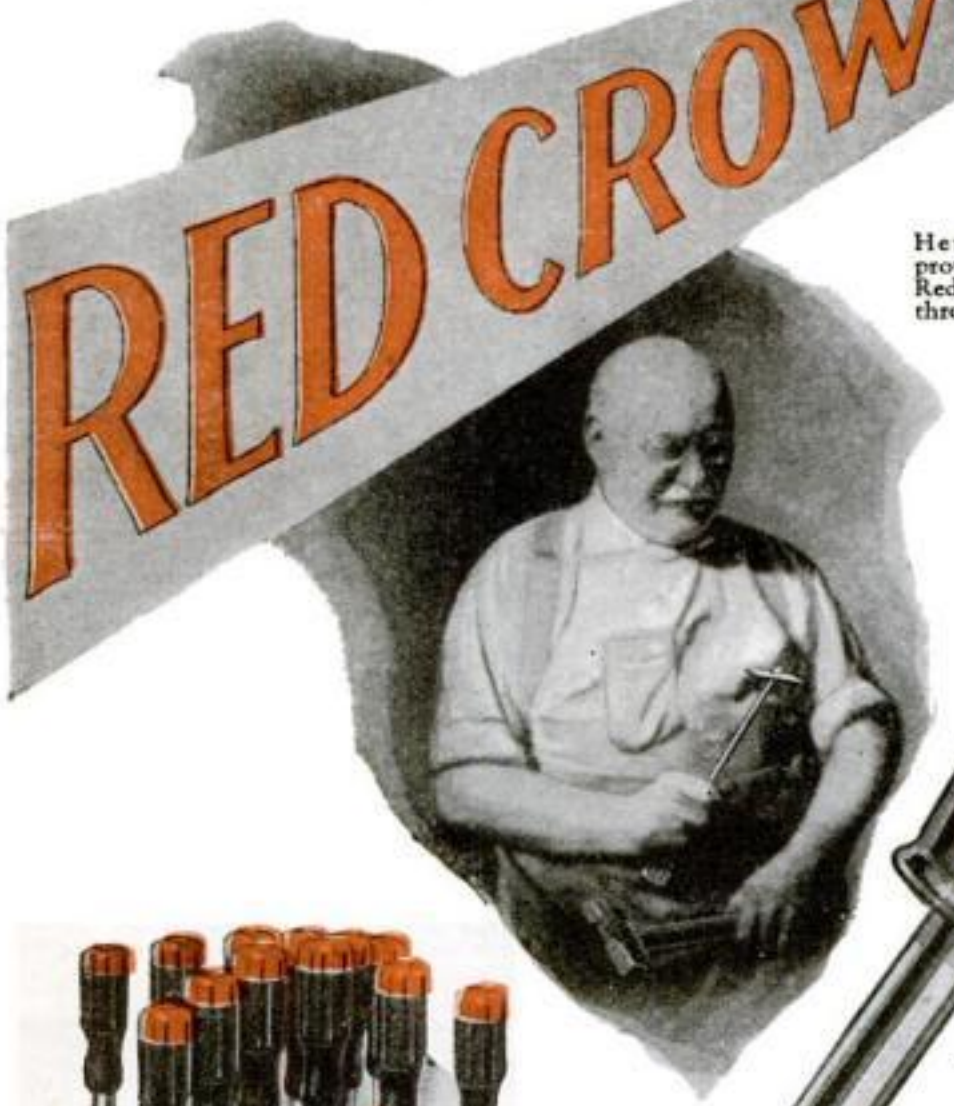
"The dry color should be mixed with a little water and stirred thoroughly, then poured into the previously made mixture of cold water *(Continued on page 112)*

Why *Craftsmen Choose*

Bridgeport

RED CROWN

You can hammer the head of a Bridgeport Red Crown all you want. Its *hexagonal head*, which is a part of the blade, takes the blows on its broad steel surface without injury.



Here the craftsman proved the Bridgeport Red Crown by driving it through a piece of ⅛" steel.

You *can't* twist the handle of a Bridgeport Red Crown. The *hexagonal head* and heavy *steel rivet* prevent twisting and loosening.

You can use the Bridgeport Red Crown as a *pry bar*. The blade is *one-piece* from the tip of the point to the hexagonal head—made of the finest steel, heat treated and *uniformly tempered* throughout.

Select your Bridgeport Red Crown from this display rack on your dealer's counter. Know this outstanding screw driver by its *bright red crown*.

SKILLED craftsmen everywhere are choosing the Bridgeport Red Crown—because there is built into it a combination of features they have never found in any other single screw driver.

Look at the transparent view. There it is shown wh Bridgeport Red Crown is able to perform an am number of tasks for which most screw drivers canno used; why it lasts far longer than ordinary screw drivers even when submitted to the severest strains of prying and the hardest blows of a hammer.

Note these features. Then total them up—compare the sum of quality in this Bridgeport Red Crown with any screw driver you have ever seen.

The bright red crown atop of the handle identifies the Bridgeport Red Crown. Look for these red crowns on your dealer's counter. 4', 5' or 6'—50¢ each. Buy your first Bridgeport Red Crown screw driver today. If your dealer cannot supply you, order direct.

THE BRIDGEPORT HARDWARE MANUFACTURING CORP.
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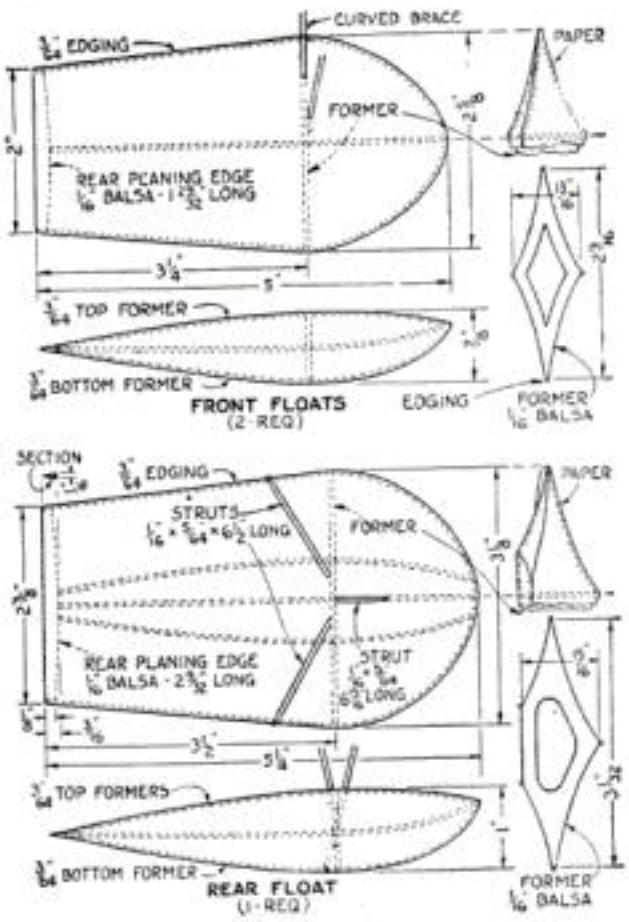
TOOLS *and* HARDWARE SPECIALTIES

You can use the Bridgeport Red Crown as a *chisel*. The point won't "mushroom". It won't break. It's DUAL tempered by the Pyrometer Process—and *twice tested* before assembly.

This Model Broke All Records

(Continued from page 104)



Front and rear floats. The top and side views and half the front view of each float are given and a detail of each of the balsa formers.

is necessary; simply insert it into the soft balsa wood exactly at the center.

Cement both sides of the hubs heavily. When this is dry, bend a small U in the end of each shaft. This end of the shaft should be in the cut-out or rear side of the propeller blade. Pull the point of this U into the balsa wood so as to leave a heavy skin of dry, tough cement between the balsa and wire to prevent the wire from pulling through the hub.

Slip two washers on each shaft. Dope the blades with two coats of paper cement, giving them a light sandpapering between coats. Then test the balance of the propellers very carefully, and check the alignment of the shaft.

TO GIVE the rear float its backbone, one balsa former 1/16 in. thick is cut out as shown above. Bend the bamboo splints and edging; these are a strong 3/64 in. square on Morris' own model. There are two splints on top of the float, and one on the bottom. The rear planing edge is formed from a piece of balsa 1/16 in. thick. It is curved at the front or thicker edge, and is sandpapered almost to a knife edge at the straight or rear edge.

To cement the float together takes a little patience Note that the front edge of each float turns upward considerably.

Next make three streamlined bamboo float struts, about 1/16 by 5/64 in., of oval cross section. Make one piece 6 5/16 in. long and two pieces 6 1/2 in. long. Make the upper ends of the float struts slightly tapered for 1/8 in. so that they will fit snugly into the small spaghetti tubing pieces which form the strut sockets.

Fasten the longer strut so that it extends to the bottom of the float, passing through the opening in the crosspiece or former from front to back, as shown. Mount the other two pieces so that they extend out equally on opposite sides from the center line and are about 3 in. from each other. Each one of the longer pieces should be about 2 in. from the shorter center strut at their outer ends as shown. Use plenty of cement in fastening the struts to the balsa former.

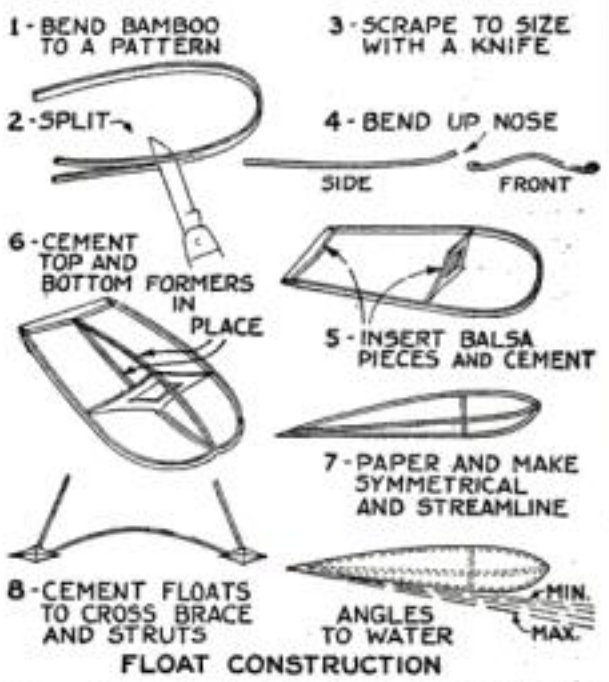
Before covering the float, waterproof the float former or framework with a good coat of paper cement. Using scraps of waterproof paper, cover the rear float, one section at a time (a section running from front to back). In papering the center section on top, it will be necessary to fit the paper closely around the struts by the cut-and-try method. Any small holes may be plastered over with a scrap of paper applied on the end of a wet cement brush. When the float is covered, dope it evenly with a coat of hydro dope. Dope the struts as well.

Test the float by holding it under water for several minutes, moving it around at different angles. To remove any water that may leak into it, pierce a small pinhole at the very edge of the float and allow the water to run to this point; then suck it out with your lips. Close the hole you made with the pin, and locate and close the hole which caused the leak.

For mounting the rear float, it is necessary to cement three pieces of the socket material to the rear X-bracing as shown. Be sure that these are set on at the proper angles. Close the upper ends of the sockets with cement. In case the struts become loose in these sockets, dip the ends of the struts in some thin cement to increase their size.

The front floats are made in the same manner with one waterproof crosspiece or former, except that they have only one bamboo strip running lengthwise on top, instead of two.

Make the two floats separately and, before covering, join them with a bamboo crosspiece 3/64 by 3/32 in., curved as shown below so that it will not catch in the waves, and mounted edgewise to the line of flight. Also attach the 1/16 by 5/64 in. oval struts which run up to the frame. These frame struts should be bent at their upper ends so that they will fit into their



FLOAT CONSTRUCTION

Steps in constructing the floats. Compare these drawings with those shown at the left above.

sockets, which you will have to mount on the inside of the A-frame.

Paper the two floats in the same manner as the rear float. Be sure to dope the struts and the cross brace between the floats.

The silk thread bracing for the front floats can be tied on, but it is suggested that you make four small hooks of No. 6 music wire, as shown on page 132. Tie a piece of the buttonhole twist about a yard long to the cross brace, right next to each float, so that the two ends will be about equal in length. Dope the four 18-in. ends of thread with paper cement.

Tie the front thread braces to small hooks, which are to be slipped over the front bamboo cross brace. Be sure that the two front thread braces are of equal length. Now cross the rear threads and adjust (Continued on page 132)

An Indispensable Product for Home Repairs
that Handles like Putty and Hardens Into Wood

PLASTIC WOOD

Reg. U. S. Pat. Off.

It is something that anyone can use—your wife or boy as easily as yourself. It is waterproof and greaseproof, and when hard can be worked with tools, adheres fast to wood, metal or plaster, will not crack or splinter, and takes paint, lacquer or varnish perfectly. Some suggested uses are:

Fixtures in Tile

For replacing a glass holder, towel rack, or other fixtures in a tile wall, clean out loose sediment from the cavity, fill with Plastic Wood, and while it is still soft force the fixture into place and allow to harden over night. A loose fixture may be strengthened by forcing Plastic Wood behind the fixture with a knife and allow to harden.

Rotted Wood

Where wood rots, as around the post of a porch rail, Plastic Wood can save expensive repairs. Scrape away all rot, dirt and old paint. Fill in or build up with Plastic Wood in layers of ¼ inch, allowing each to dry, to slightly above the surrounding surface. When hard sandpaper or plane it smooth, and paint.

Vines on Stucco

To train vines or ivy on stucco, brick or stone where guide wires are needed but cannot easily be made to hold, small knobs of Plastic Wood can be attached to the wall, and when hard will hold tacks or staples for fastening the guide wires or string.

Home Carpentry

Plastic Wood has become an essential for the amateur carpenter. It is the one product that successfully repairs cracks, splinters, or blemishes in wood—forming new wood—and is most satisfactory for sealing joints and corners, building up wood surfaces, and permitting a smooth hard finish to the job.

Uneven Furniture Legs

When a piece of furniture stands unevenly, build up the short leg with Plastic Wood slightly higher than is necessary. While still soft replace on four legs with a thin piece of paper on the floor (to prevent adhesion of the Plastic Wood). Smooth off the Plastic Wood around the edges, and when hard, tear off the paper.

Leaky Window Frames

For cracks and leaks around the window frame—with tile, brick, or stone house construction as well as wood—Plastic Wood is the perfect filler. It is waterproof and weatherproof, and can be applied equally well outside or inside the house. If the Plastic Wood filling is noticeable it is easily painted to the color of the frame.

Countersunk Screws

For boats, or wherever countersunk screws or fastenings are to be covered, Plastic Wood is of immediate value. Press Plastic Wood firmly into the hole, allowing it to stand slightly above surrounding surface. When hard, sandpaper or plane to smooth finish. Varnish or paint as desired.

Broken Mouldings

On picture frames, walls, carved wood mantels or panels, when the moulding is chipped, split or broken off, Plastic Wood can be readily moulded to repair the missing or damaged piece. It will adhere fast to the base, and when hard can be gilded, painted or stained to the desired color.

Split Chair Backs

For a split chair back, either in the panel or frame, use Plastic Wood. Carefully scrape away dirt and paint from the split, and both sides of it. Force Plastic Wood through the split, and using the thumb with a wiping motion, press it firmly over all edges. When hard, sandpaper smooth and paint.

Holes After Wiring

Where holes are bored for radio or other electrical wiring, Plastic Wood, with a volume resistivity of 10^{12} ohmcentimeters, is the perfect filler. It will hold permanently fast, can be painted or varnished to the color of surrounding woodwork, and for outside exposure is waterproof and weatherproof.

Plastic Wood is carried by Hardware and Paint Stores and by Ship Chandlers. It comes in natural wood color in 1 lb. cans at $1.00, and in ¼ lb. cans at 35 cents.

For replacing loose tiles in a bathroom, or where a flat white finish is desired, use Plastic Wood White Waterproof Tile Cement, at the same prices as Plastic Wood.

When working with Plastic Wood or the Tile Cement, it sometimes becomes necessary to soften or thin it, and because of its adhesiveness it will stick to tools or fingers. To soften or remove it, use Plastic Wood Solvent, in 25 and 50 cent cans.

Manufactured by The Addison-Leslie Company, 313 Bolivar Street, Canton, Mass.

PLASTIC WOOD

Reg. U. S. Pat. Off.

Blueprints for Your Home Workshop

OUR blueprints can be obtained for 25 cents a sheet. In some cases there are two or three sheets to one subject. The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine in which the project was described in detail, it can be had for 25 cents additional so long as copies are available. Other subjects besides those below are to be had; send a stamped envelope for the complete list.

Popular Science Monthly,
250 Fourth Avenue, New York

Send me the blueprint, or blueprints, I have underlined below, for which I inclose.....dollars.....cents

No.	Title	Described in Issues of		Price
2.	Smoking Cabinet	*Mar.,	'22	25c
5.	Kitchen Cabinet	*May,	'22	25c
15.	Workshop Bench	*Jan.,	'23	25c
27.	Kitchen-Cabinet Table	Oct.,	'23	25c
30.	Tool Cabinet, etc.	*Jan.,	'24	25c
31.	Sewing Cabinets	Feb.,	'24	25c
37.	Simplified Bookcase	Dec.,	'24	25c
43.	Four-Tube Receiver (battery operated)	*July,	'25	25c
44–45.	Pirate Ship Model	*Feb.,	'26	50c
46–47.	Galleon Ship Model	May,	'26	50c
48.	Sailing Yacht Model	*July,	'26	25c
50.	Airplane Model (Rise-off-ground tractor, 36 in.)	*Sept.,	'26	25c
51–52–53.	Clipper Model, *Sovereign of the Seas*	*Oct.,	'26	75c
54.	Five-Tube Radio Set	*Oct.,	'26	25c
55.	Five-Tube Set—Details	*Oct.,	'26	25c
56.	Bird and Animal Toys	Dec.,	'26	25c
57–58–59.	*Constitution* Ship Model ("Old Ironsides")	*Jan.,	'27	75c
60.	Welsh Dresser	Mar.,	'27	25c
61–62.	Viking Ship Model	Apr.,	'27	50c
63–64.	Toy Motor Boat, 29 in. long hull	May,	'27	50c
65.	Six Simple Block Puzzles	June,	'27	25c
66.	Ship-Model Weather Vane	Aug.,	'27	25c
67.	Toy Model of Lindbergh's New York-to-Paris Plane	Aug.,	'27	25c
68.	Magazine-Rack Table and Book-Trough Table	Sept.,	'27	25c
69.	Flying Model (3 ft.) of Lindbergh's Monoplane	*Oct.,	'27	25c
70.	Console Radio Cabinet	Nov.,	'27	25c
71.	Console Cabinet—Details	Nov.,	'27	25c
72.	Doll's House	*Dec.,	'27	25c
73.	Doll's House Furniture	*Dec.,	'27	25c
74–75–76.	*Santa Maria* Ship Model, 18 in. long hull	*Dec.,	'27	75c
77.	Simple Pier Cabinet and Decorative Wall Shelves	Jan.,	'28	25c
78.	Simple Treasure Chests	Feb.,	'28	25c
79.	Electric Radio Set	Feb.,	'28	25c
80.	High Power Unit for Electric Radio Set	Mar.,	'28	25c
81.	Low Power Unit for Electric Radio Set	*Apr.,	'28	25c
82.	Simple Single-Stick Airplane Model (30-in.)	Mar.,	'28	25c
83–84–85.	*Mayflower* Model	Apr.,	'28	75c
86.	Racing Airplane Model (35-in. twin-pusher type)	May,	'28	25c
87.	Seaplane Model (30-in.)	June,	'28	25c
88.	Simple Modernistic Stand; Modernistic Bookcase	Aug.,	'28	25c
89–90.	*Bremen* Scale Flying Model (3-ft.)	Aug.,	'28	50c
91.	Modern Folding Screens	Sept.,	'28	25c
92.	Simple Baltimore Clipper Ship Model (8 in. long)	Sept.,	'28	25c
93.	Three Modern Lamps	Oct.,	'28	25c
94–95–96.	Mississippi Steamboat Model	Nov.,	'28	75c
97.	Modern Electric Radio Set in One-Tube Form	Nov.,	'28	25c
98.	Modern Electric Radio Set in Two-Tube Form	Dec.,	'28	25c
99.	Modern Electric Radio Set in Four-Tube Form	Jan.,	'29	25c
100.	Modernistic Book Ends, Book Shelf, Low Stand	Dec.,	'28	25c
101.	Toy Fire Engine, Sprinkler, Truck, Tractor	Dec.,	'28	25c
102.	Morris Seaplane Model	Mar.,	'29	25c
103.	One-Tube Battery Radio Set (Old No. 41 revised to	Mar.,	'29)	25c

*Magazine only out of print.

Name.....
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Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

35146

HOME workers are familiar with the ordinary commercial cleansers, soap powders, scouring powders, and the like, but sometimes overlook the cleansing characteristics of common chemicals.

Oxalic acid is used to bleach stains on wood, to remove rust stains, and to clean copper, brass, and bronze. Placing 1 oz. of the crystals in an 8-oz. bottle will give a saturated solution. This liquid, which is poisonous, will quickly remove tarnish by dissolving it. When the metal is clean, wash it with plenty of water and dry and polish it by rubbing with dry whiting or other mild abrasive, which polishes it.

Gasoline—never forget for a moment how inflammable it is—is excellent for dissolving fats and grease. Only small quantities should be used. Carbon tetrachloride, which will not burn, may be used in its place. This last named chemical also is often used in fire extinguishers.

Making a fire-extinguishing bomb by breaking off the bottom tip of an electric lamp so that the bulb will fill with carbon tetrachloride.

Bombs for putting out small fires may be made by filling old electric light bulbs with carbon tetrachloride. Such bombs, if hurled into a small blaze so that they break, will quickly bring it under control, especially if a number of them are at hand. The bulb is filled by heating the screw base, twisting it off, holding the lower end of the lamp under the liquid, and breaking its tip.

Turpentine is used primarily to thin paints, although it also serves to dissolve wax. It will remove paint from clothes, but only if the paint is not too old and too hard.

Steel wool, which can be obtained in various grades of fineness, is excellent for removing varnish and paint and for cleaning aluminum, the finest grades being used for the latter purpose. Another method of cleaning aluminum of any discolorations is with alkali-free soap or, if this does not help, with dilute oxalic acid—but all of the acid must be thoroughly washed off.

Kerosene loosens dirt, dissolves grease, and also removes paint from the hands and from brushes.—ERNEST BADE.

Painting Basements

(Continued from page 102)

Chart for Tinting White Paint

To Make—	Tint White with—
Ivory	Chrome yellow medium or raw sienna.
Cream	Yellow ochre (with a touch of Venetian red and white, if desired).
Buff	Yellow ochre.
Colonial yellow	Raw sienna and chrome yellow medium (about equal parts).
French gray	Raw umber with a little lampblack added.
Steel gray	Lampblack with a touch of ultramarine blue.
Warm gray	Yellow ochre with a touch of lampblack and Venetian red.
Drab	Yellow ochre and raw umber (about equal parts).
Slate	Lampblack.
Pea green	Chrome green medium and chrome yellow (about equal parts).
Sky blue	Ultramarine blue (a very little, added cautiously).
Light brown	Burnt umber, burnt sienna, and raw sienna (about two parts of the umber and one part each of the sienna).
Chocolate brown	Burnt umber and about one third as much burnt sienna, with a touch of chrome yellow medium added.
Terra cotta	Yellow ochre with a little Venetian red.

paint and water. This will prevent any tendency toward streaking caused by undissolved particles of dry color. Each color, as, for instance, the raw umber and the lampblack, should be mixed and added separately.

"In conclusion, here's something you might like to have," I said, handing him a card with a table like the one above. "It's a tinting chart and tells what colors to use for tinting white to different popular shades. And, by the way, it would be a good idea to keep this chart, as the same tinting colors can be used for tinting regular oil painting materials—only oil colors would, of course, want to be used for tinting, instead of dry colors."

Pipe Clay Removes Marks from Wall Paper

FINGER marks can be removed from wall paper by dampening them with cold water and dusting on a little powdered pipe clay or fuller's earth. After the powder has been on the paper for a few minutes, remove it with a soft brush.

For spots that are greasy and more stubborn than finger marks, first apply a clean blotter and press it with a hot iron. Having extracted all the grease possible in this way, finish the cleansing with powder as suggested before.

McCann Founds a Ship Model Makers' Club

Capt. E. Armitage McCann, who designed for POPULAR SCIENCE MONTHLY its entire series of historic ship models and has been the recognized leader of the ship model building hobby since it became a popular pastime three years ago, has founded the Ship Model Makers' Club. Gordon Grant, distinguished marine artist, is the president and Captain McCann the secretary and treasurer.

The chief object of the club is to bring ship model makers in the same district in touch with one another, so that they may, if they desire, work together, compare their work, and have the acquaintanceship of neighbors with similar interests. It is planned to hold national and district exhibitions of ship models. The club's headquarters are at 55 Middagh Street, Brooklyn, N.Y.

River Packet Model

(Continued from page 98)

practically no framing. Boats of this type were used in the fast river-packet days for sounding. They could be pulled on to the machinery deck by the deck hands and launched from the guards almost instantly. The sounding boat was manned by four rowers in the seventies and later by a crew of three and a pilot's cub. It was said that these boats drew about as much as a mallard duck!

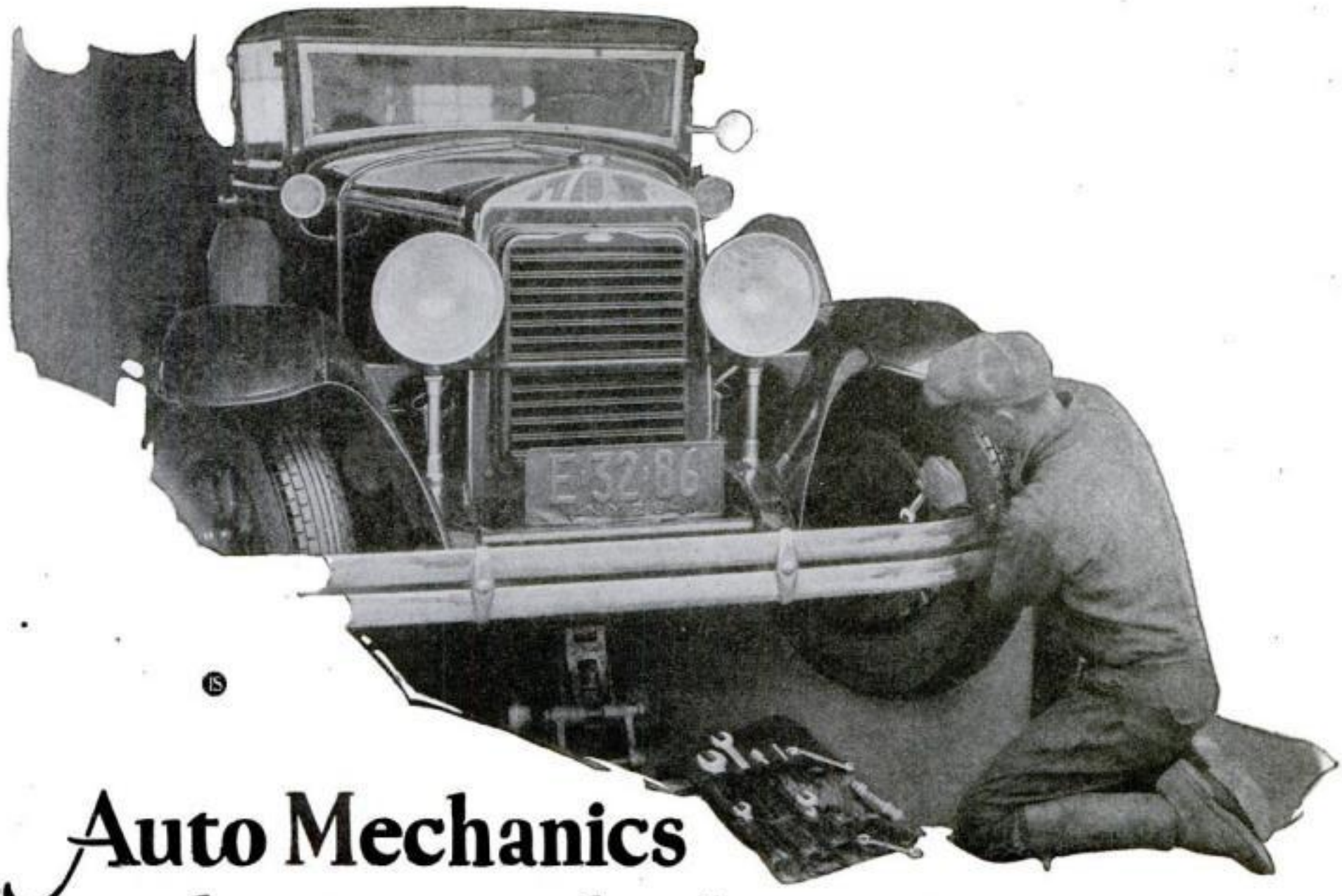
FOR my model I made one square-sterned and one double-ended boat, which stand on chocks on the upper deck, one on each side. The boats are about $\frac{3}{8}$ in. wide and $1\frac{3}{4}$ in. long. There are eyebolts in each end of the boats for the hook blocks and ropes by which they are connected to the davits.

The gangplank is nearly $\frac{1}{2}$ in. wide and about $2\frac{1}{2}$ in. long. The sidepieces are slightly wider at the center than at the ends. The plank is hung by U-irons, bolted to the sides. It is suspended from the derricks with blocks and falls as shown on page 96 and more clearly on Blueprint No. 96. The derrick posts are $\frac{1}{8}$ in. in diameter, slightly tapered, and $3\frac{1}{2}$ in. long measured from the deck; they are set 2 in. apart. They extend into the lower deck and are bolted to the edge of the boiler deck. Just below the boiler deck the derrick booms are fastened to the posts with goosenecks. The top ends are raised or lowered with two single block tackles, so that the gangway may be swung out to either side. Many of the boats had double gangplanks, only the outer end of which was pulled up, but that of the *Buckeye State* was as shown on page 98.

The forward flagpole is $5\frac{1}{2}$ in. long and has a gold ball $1\frac{1}{4}$ in. below the top. The long pennant flag bears the name of the ship. There is a small weather vane at the top of the pole. At the after end of the upper deck, a shorter pole carries the American flag with thirty-eight stars.

On the fore deck is a set of mooring bitts on either side with a capstan between.

A touch of paint, lacquer, or varnish here and there will complete your model. It may stand flat or be raised on short turned pillars and mounted on a shelf or other support, or, if it is likely to be in the way, it may be screwed to a wall bracket. Another plan is to place it in a scenic shadow box with imitation water and painted background. This method, which gives the model a very effective setting, will be described next month.



Auto Mechanics
.... here's your brake set!

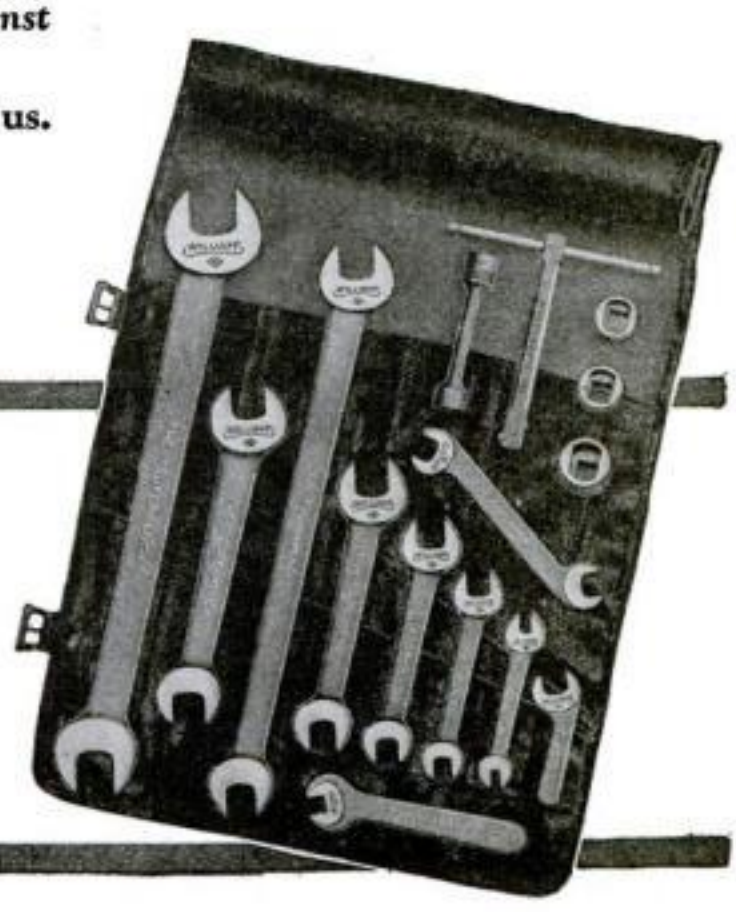
Right at hand—the NEW Williams' Set No. 1950—doing the job faster and easier. Ten open end and four socket "Superrenches"—a shape and an opening for adjusting brakes on all popular cars, *including 1929 models*—Lockheed Hydraulic, also Bendix, Steeldraulic and other mechanical types.

The most awkward adjustments are made easy. Various shapes and lengths of wrenches for the hard-to-reach places; different angles of openings to get around obstructions; sockets for otherwise inaccessible positions. A *complete* Brake Set, always ready for use and—*Every "Superrench" is guaranteed for life against breakage.*

If your dealer can't supply this NEW "Superrench" Set, write us.

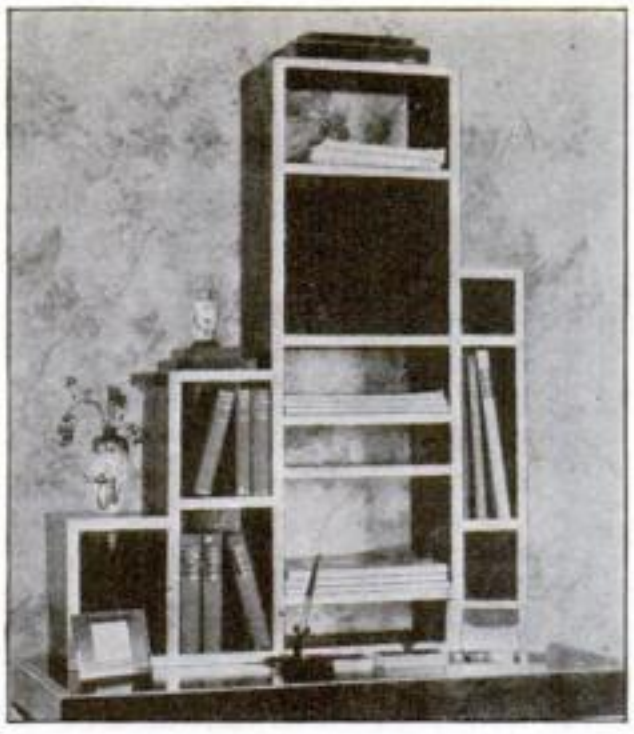
J. H. WILLIAMS & CO.
"The Wrench People"
New York — BUFFALO — Chicago

Write for your copy of the interesting booklet on Williams' "Superrench" Brake Set No. 1950. It contains a valuable chart showing type of brakes, adjustments necessary and the particular wrench required in servicing all popular 1929 and earlier cars. It's free.



WILLIAMS
SUPERIOR DROP-FORGED TOOLS
"SUPERRENCH"
(Chrome Molybdenum)
BRAKE SET No. 1950

Modernistic Fire Screen
See LePage's Book, page 13



Modernistic Book Shelves
See LePage's Book, page 9

Modernistic Table
See LePage's Book, page 11

Now You Can Make Your Own Modernistic Furniture

At a Fraction of Store Prices

LEPAGE'S New Book Shows How

LePage's latest book, "The Third Home Work Shop Book," contains complete directions for making 20 attractive pieces of household furniture, 5 of which are modernistic in design, so popular today. These include the 3 shown above, and in addition, a Modernistic Desk and Modernistic Folding Screen.

Or, if you prefer, you can make reproductions of 5 famous old Colonial pieces—Cape Cod Chest of Drawers, Alexandria Nest of Tables, Old Salem Ship's Cupboard, Plymouth Built-In-China Closet and Lady Washington Sewing Cabinet.

Expert Instruction

Any man handy with tools can make any or all of these 20 pieces of furniture, for a fraction of their retail price, which a careful check in shops showed would be about $1000 for the 20.

You have expert instruction to guide you. The designs, dimension drawings, photographs, step-by-step directions and the actual furniture itself were made by William W. Klenke, Instructor in Wood-working, Central Commercial and Manual Training High School, Newark, New Jersey. His experience as an expert gives assurance that each project and the directions for making it are thoroughly practical.

The other popular 10 pieces which this LePage's Book shows you how to make, are: Chess and Checkers Table, Smoking Table, Caned Side Chair, China or Book Cabinet, Book Trough and Magazine Stand, Magazine Carrier, Vanity Case, Book Stand, Fernery Stand and Folding Sewing Screen. Where else could you get complete directions for making all these for only 10 cents?

Send 10 cents for this NEW LePage's Home Work Shop Book

Simply use the coupon below, sending it to us with 10 cents in coin or stamps, and we will at once send you a copy of this latest LePage's Book, postage paid.

12 NEW Job Plans, *Too!*

There is, of course, a limit to what we can give in LePage's New Third Home Work Shop Book for only a dime. But we realize many men want additional projects. Hence our 12 new Job Plans. These also were made by Mr. Klenke. They are projects that require more elaborate presentation than we can give in our book. Each Job Plan presents one project on a single large sheet of paper. Each is well worth its price, one dime. Look over these projects and order those you want by number (see coupon), enclosing 10 cents for each.

16 Sheraton Writing Desk
17 Sheraton Desk Chair
18 Colonial Hanging Book Shelves
19 Smoking and Reading Cabinet
20 Colonial Mirror
21 Tea Wagon
22 Telephone Cabinet
23 Stool for Telephone Cabinet
24 Manual Training Work Bench
25 Home Worker's Tool Cabinet
26 Spanish Galleon
27 Vanity Table

LE PAGE'S GLUE
HANDIEST TOOL IN YOUR WORKSHOP

MAIL THIS COUPON

LEPAGE'S CRAFT LEAGUE
613 Essex Ave., Gloucester, Mass.

Gentlemen: Enclosed please find 10 cents (coin or stamps) in payment for LePage's New Third Home Work Shop Book. Please send a copy of this book to:

Name.....

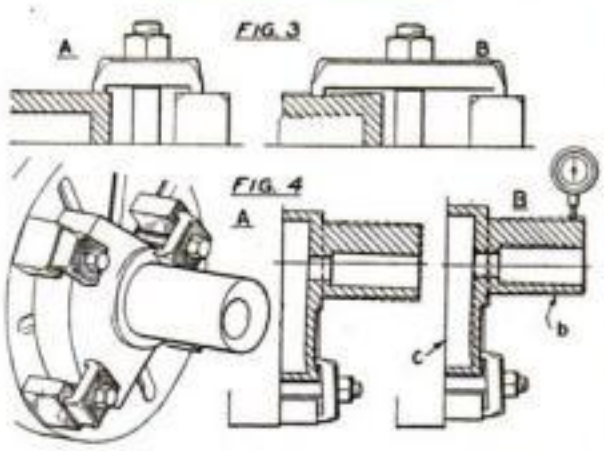
Street.....

City.....State.....

Please also send the following Job Plans.....
(Indicate by number those you want. See column at left), for each of which I enclose an additional 10 cents.

Dodging Errors

(Continued from page 94)



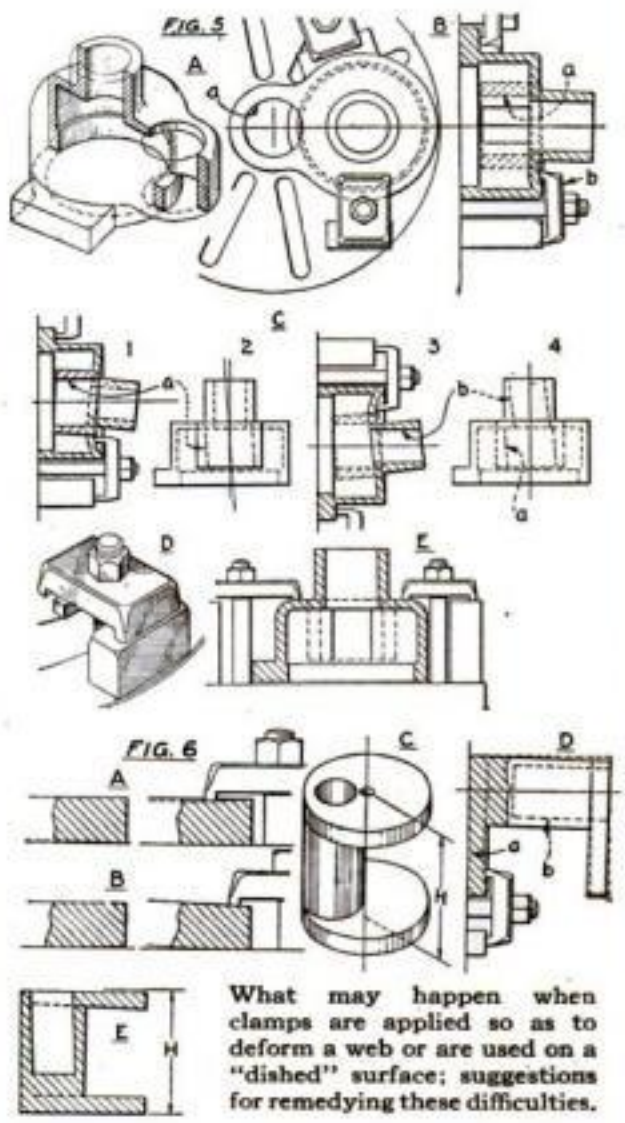
Undercut parts must be clamped in such a way that the pressure is on the solid metal.

the only remaining evidence of the "double crime" is a disalignment of the bottom surface *c*, which is likely to be of no consequence.

Nevertheless right remains right. The cost of jockeying with the clamps to cause an error that will exactly offset a previous error is in itself often excessive. And there are times where we cannot make dog eat dog. Take the case portrayed in Fig. 5 at *A*. In holding the part for finishing diameter *a*, as shown at *B*, the clamp *b* deforms the web on one side. What happens then is shown graphically in the "comic strip" at *C*.

At the finish of the first operation on bore *a*, the work looks as at 1, and as at 2 after it is removed from the faceplate. If it is now reset to finish diameter *b* so that the small bore *a* indicates right, it will look as at 3; and, after being removed from the faceplate, it will appear as at 4. If, however, it is intentionally or accidentally clamped right the second time, then it will still be out as at 2. Nor is the result, though slightly different, any better if diameter *b* is finished first, so long as the web is bent by the clamp.

In other words, after the part was once wrongly lined up for the first operation, there will be trouble no matter what is done later. The proper way is (Continued on page 118)



What may happen when clamps are applied so as to deform a web or are used on a "dished" surface; suggestions for remedying these difficulties.

--Then Everything Went Black!

HENRY J. ELBOW, prominent for many years in pipe circles, tells how it all happened:

"It all took place so unexpectedly that it seems like a bad dream. I was sitting tight, as you might say, slightly rusted, and secure in the knowledge that nothing could move me."

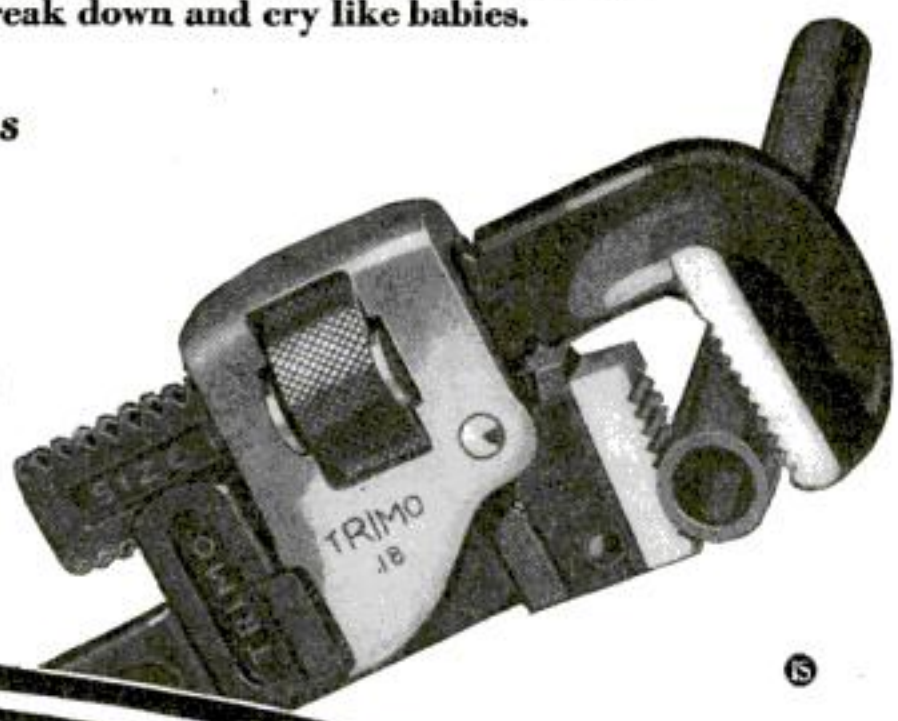
"Something hard and sharp grabbed me about the waist; I was spun dizzily around, heard a coarse chuckle—then everything went black."

Life is like that, men, when a Trimo pipe wrench meets a pipe. This Improved and Mightier wrench has a grip that never slips and a heat treated handle that will stand the hardest pull. Trimo jaws and Trimo grip make strong pipes break down and cry like babies.

Hardware and Supply Dealers Everywhere Sell

TRIMO

TRIMONT MFG. CO., INC.
ROXBURY (BOSTON), MASS.



IMPROVED and MIGHTIER

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Dodging Errors

(Continued from page 116)

to clamp correctly. If clamps of the proper length are not on hand, then the right way is something like that shown at *D*. By making the clamps bear down on the pieces of square stock *a*, the strain is confined to compression of the solid metal, and trouble is avoided.

At *E* is shown another way, and one suited to holding the work if the corners are heavily rounded. By using two equal clamps nearly opposite each other and placing thin paper underneath the work, the strain may be reduced and evened up to the point where the distortion caused is no longer appreciable.

Even an old hand may occasionally overlook the condition pictured at *A*, Fig. 6. Here the bottom surface of the work shown at *C* is slightly "dished" because of wear on the tool on the finishing cut. Such a condition is usually considered a "good fault," as against that shown at *B*, which is always bad. The difference may only be a thousandth or two, but when the clamps are tightened, the dished surface is drawn right up to the faceplate, the base *a* being bent and the column *b* and the hole disaligned as at *D*, so that the finished work will look as at *E*. We need only suppose the part to be one on hand in which the bore is to be enlarged, and with nothing to go on distance *H*, to see that such an error may prove to be exceedingly awkward.

In his next and fifth article, Mr. Simon, who is a distinguished authority on machine shop problems, will discuss other methods of avoiding distortion.

Cylindrical Grinding

(Continued from page 92)

commercial cylindrical grinding. Three centers should be cut down as at *A* to accommodate different diameters.

When grinding a spindle as in Fig. 3, it is advisable to fit a soft steel plug as shown. Although the work may be done by using a large center, it will revolve much easier on a small center, and the results will be more satisfactory.

In grinding a piece of work of small diameter and considerable length, even if the wheel is fed carefully, a slight spring in the work results, causing a finish sometimes much worse than a lathe job. In this case the back rests permit taking a heavier cut by increasing the speed and feed.

THERE is nothing complicated in the use of the back rests. It is necessary only to spot the work the width of the wheel in a location where the rests are going to be set, as in Fig. 4, and adjust them as in Fig. 5. The locations on the work are generally spotted to a diameter .008 in. more than the finished size; the removal of the remaining .008 in. will not materially affect the tension.

In grinding work of one diameter, the first cut should go as near the dog as possible, so as to leave a short length for the last cut.

For grinding a number of duplicate pieces, several ways may be resorted to so as to do the job in a single cut. If the work is large enough in diameter, a small hole is drilled in the end of each piece for a pin to be used as shown in Fig. 6. The work is driven the usual way. Of course, this applies only to regular cylindrical grinding machines.

Figure 7 shows how small work may be ground in one cut on universal grinding machines, using a live head center.

As to the revolving speed of the work and the feed of the table, there are no specific rules to go by. The following suggestions may be helpful, as they have proved reliable in long use. For soft steel the table should travel about two thirds the width of the wheel for each revolution of (Continued on page 120)

CAREFUL SELECTION

For work that requires skill and craftsmanship, you need good tools. So, naturally, you select the tools you use as carefully as you undertake the work itself. When you find a tool, such as PEXTO, that gives you satisfaction, that combines exact balance with guaranteed workmanship and material, why not multiply that satisfaction by the other numbers of the line? You will find every Pexto Tool made with a view to expert handling and long life. Experience in tool-making, dating back over one hundred years, is a valuable asset in fine tool manufacturing.

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PEXTO

Cylindrical Grinding

(*Continued from page 118*)

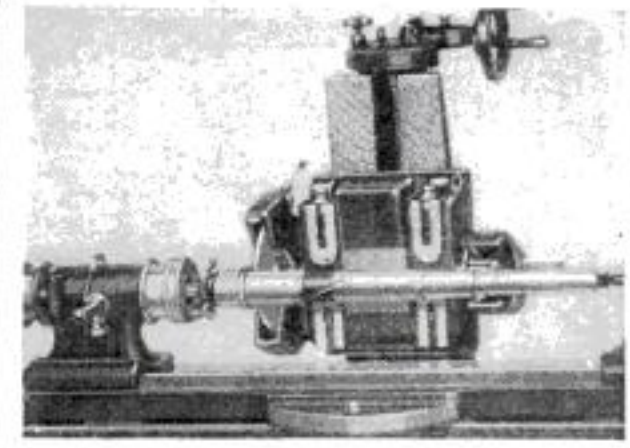
the work; for hardened steel, it should travel from one third to one half the width of the wheel for each revolution of the work. Poor application of these rules will cause a screwlike finish and chatter marks on small work and a rough finish and vibration marks on rigid work.

The width of the wheel on cylindrical grinding machines in the small shop is generally ½ in., which permits grinding short pieces and is also satisfactory for long work.

When grinding to a shoulder, set the wheel thereto and feed in to within .001 in. of the finished size; then square the shoulder. It is thus easier to set the left stop without danger that the wheel will strike the shoulder. The remaining .001 in. is removed by hand feeding.

Figure 8 shows the proper position of the diamond in relation to the wheel.

Grinding wheels on plain cylindrical grinding machines should be concave on t.e squaring



How a universal grinding machine is used in squaring a shoulder on a large spindle.

side about half a degree. On universal machines the construction is such as to permit getting this result simply by turning the wheel carriage an even amount to the left.

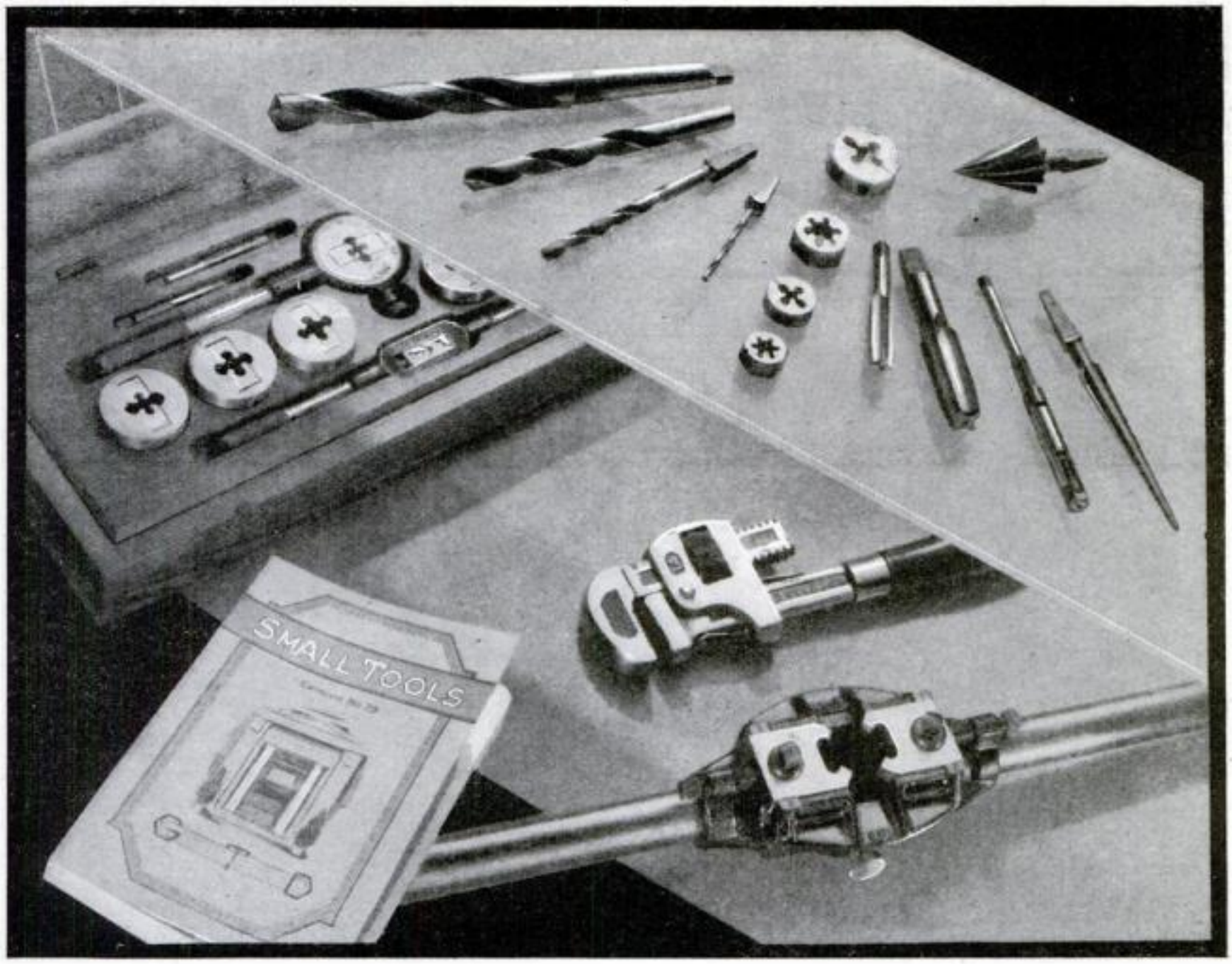
The other type of cylindrical grinding very common in any shop is taper work. In grinding tapers accurately, some standards of duplication are necessary, especially for new work. As a matter of fact, the work done is generally to replace some part or tools previously used and worn out.

I have noticed that the small shop has very poor equipment for turning out taper work, often because of the lack of a set of taper plug gages, which are rather expensive but very useful. Let us take it for granted that the tapers to be ground are to be fitted to their respective spindles; in this case the old part or tool generally accompanies the order.

The shop should have at least a proper taper parallel gage; there is no reason to be without one. In Fig. 9 is shown a taper gage which can be made cheaply and will answer the purpose well. It will prove useful either for lathe or grinding operations. It consists of two pack-hardened, ground parallels fitted to a piece that has been bent as illustrated. This, in turn, is bolted to a cylindrical bar and held in a pedestal of some sort; or else the bar may be square and the outfit held in the vise, which is generally near by.

In fitting a taper to the parallels, see that the work is central as in Fig. 10, which also shows how the taper is slightly relieved in the center so as to bear on the ends only. This is a good practice to adopt, as old spindles are more or less high in the center.

The speed of the wheel remains constant, regardless of the material being ground. With a wheel of grade K or harder, a surface speed of from 6,000 to 7,000 ft. a minute gives good results on almost any material. Hardened steel may be ground more satisfactorily at a speed of from 5,000 to 6,000 surface feet. Wheels softer than grade K should never be run faster than 5,000 surface feet.



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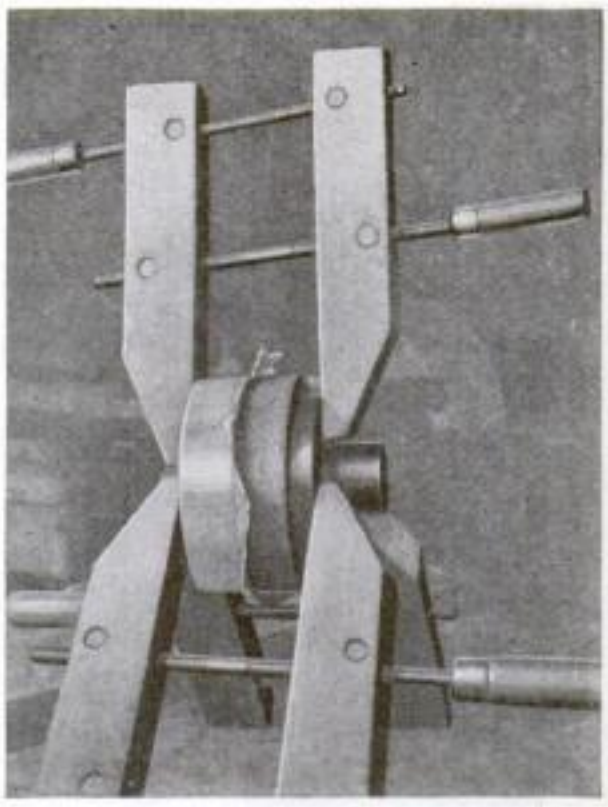
How to Turn Trays

(Continued from page 81)



How the wood for a tray is glued to a piece of waste stock with a sheet of paper between.

turn the tray as shown in Fig. 5, page 81.

Besides an inset in the center, which is inlaid in the manner described above, this tray also has a line inlay. Ordinary straight lines of inlay cannot be bent to form a circle of such a small diameter. This line is therefore turned from a piece of veneer in the form of a ring.

To accomplish this, a piece of ⅛-in. veneer is glued to a circular disk, with a piece of cardboard between the disk and the veneer as in Fig. 6. When the glue is dry a ring of the desired width and diameter is turned from the veneer. Use two pairs of dividers with very sharp points, one pair to mark the inside diameter of the ring, and the other pair to mark its outside diameter. Mark lightly, then cut on these lines with the toe of a very sharp ¼-in. skew chisel. The ring can now be separated from the cardboard layer.

Mark the bottom of the tray without resetting the dividers, turn a recess for the ring, and glue it in place. When the glue is dry, face off and sandpaper the inlaid bottom, and stain and polish the tray.

The tray is removed from the waste stock by driving a sharp chisel into the latter 1/16 in. back of the glue joint. This will cause the paper between the tray and the waste stock to split. The tray may now be chucked as shown in Fig. 7 for the purpose of cutting the recess on its underside. The chuck may be made from the waste stock.

A supplementary design for a pin tray, which is turned by the same methods, is given for those who wish further practice in this branch of wood turning.

This is the tenth of a series of articles on wood turning by a distinguished teacher and supervisor of shop work and the author of *Reproduction of Antique Furniture*. The next article is scheduled for early publication.

TO DRIVE a small homemade wood turning lathe, I am utilizing the motor of a washing machine. The machine is wheeled up to the lathe and the rollers are blocked so that there can be no movement. The three-cornered belt is slipped off the motor and a flat belt is used to connect the motor and the lathe pulley. Marks on the floor allow the washing machine to be aligned quickly with the lathe. When a washer is of the closed side type, as mine, an opening must be made on the pulley side of the motor to allow the belt to pass.—H.G.T.

Easily Built Table for Playing Games

Costs Less Than $10 for Materials —Has Felt-Covered Wall Board Top

By H. D. SMITH

Matching skill with cues on this homemade game table is good sport for winter evenings.

ANYONE who is interested in home life in general and in the home workshop in particular will have a good time making and using the game table illustrated above. This one has given pleasure in our home on many occasions. It is simply yet substantially built, and when not in use may be folded and kept in any out-of-the-way place.

The lumber used was of the grade often sold for crating purposes. The sizes of the various pieces, which are given in the accompanying list of materials, were made to conform to the lumber dealer's mill list.

As will be seen from a study of the drawings, the frame was joined by the cross-lap-joint method so as to make the top edges of the frame pieces even. The pieces of the frame were so placed as to have a piece of the frame on each inner side of each pocket.

Upon the frame a sheet of fiber composition wall board was nailed. A heavy, flat gypsum wall board would have made a firmer and smoother surface, more like the regular billiard tables, but we preferred the lightness of the paper composition. Pockets were located in each corner and at the sides.

Over the wall board the felt cloth was spread, pulled taut, and fastened with thumb tacks. In each of the pockets the felt was fastened either to the underside of the wall board or to the woodwork of the frame.

Around the frame, to hide the edge of the wall board, pieces of trim, 2¼ in. wide, were fastened with screws to the ends of the frame pieces. These pieces were mitered at the corners.

The stock for the "cushions" was next shaped to form the entrance to the various pockets by cutting the ends at 45°. The inside edges of these pieces were then grooved ¼ in. wide so that the top edge of the groove was ⅛ in. from the top side of the cushion. Into this groove half of a ⅜-in. rubber tire was forced and fastened with small brads, the heads being set well into the rubber.

This tire, from which the rubber "cushion" pieces were made, was cut in half by pulling it through a ½-in. hole in a block of wood into which a razor blade had been set, as illustrated. The cushion pieces were next covered with felt and secured to the top of the table with round-headed screws.

The legs and the rails were fastened together with bolted joints. Then the leg units were fastened to the frame with hinges so placed that one unit came between the legs of the other. Each unit was made rigid in an upright position by the use of a 12-in. hook and eye extending from the lower rail to the underside of the frame.

CUE sticks might have been made from old broomsticks by working one end down to ⅜ in. in diameter and tapering the sides to the largest possible diameter at the other end. We have found, however, that ½-in. dowel rods, 36 in. long, answer nicely as cues, so we have not yet made the heavier ones. Dowels can be obtained at large hardware stores and woodworking plants.

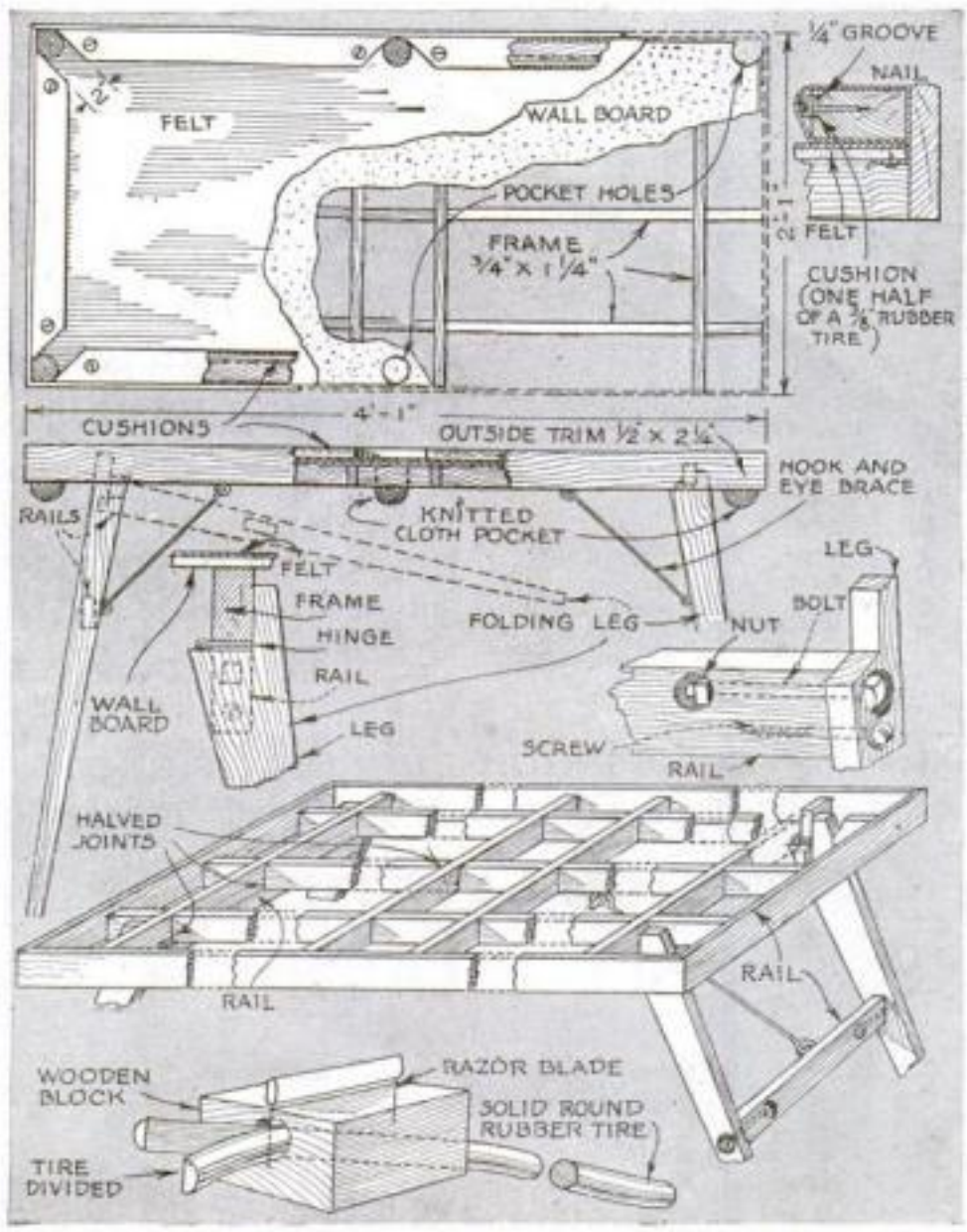
The cost of the table was a little less than $10. The felt cloth of the kind from which banners are made was bought at the local department store for a little less than $3. The pool balls were expensive because there is little call for them, except as part of a complete outfit. A local toy store was willing to order them at a cost of about the same as the felt. The other materials and hardware, which were readily obtained, brought the total up to the figure named—a small expenditure considering the enjoyment the game board gives us during many long, inclement winter evenings.

MATERIALS NEEDED

TWO pair 2-in. common butt hinges; felt, 72 in. wide and 45 in. long; fiber or heavy plaster wall board, 24 by 48 in.; eight ¼-in. square-head machine bolts 2½ in. long, with washers; eighteen 1¼-in. No. 8 flat-headed screws; twelve 1½-in. No. 9 round-headed, blue, or nickel screws; eighteen 2-in. No. 10 round-head, blue or nickel screws; two 12-in. hooks and eyes; four ½-in. dowel rods 36 in. long; 6 ft. of ⅜-in. hard rubber tire; three 10-cent knitted dish cloths; one box thumb tacks; set of 1¼-in. pool balls. Wood as follows:

No. Pcs.	T.	W.	L.	Parts
4	¾	1¼	24	Frame
3	¾	1¼	48	Frame
6	¾	2¼	24	Cushions
2	½	2¼	25	Trim
2	½	2¼	49	Trim
4	¾	2¾	30½	Legs
2	¾	2¾	22	Rails
2	¾	2¾	20	Rails

All dimensions are in inches.



Top view of the game table partly broken away to show the framework; side view indicating how the legs fold; details of joints and cushions.

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A Garage Workshop

(Continued from page 86)

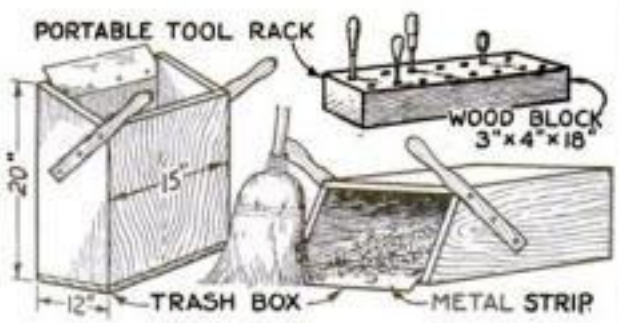
anywhere in the shop as may be required.

The saws are hung on nails along the wall near the woodworking vise; boxes and cans of nails, screws, nuts and bolts, paint, sandpaper, and other small articles are kept on the shelves at either end of the workbench. Hammers and wrenches have their racks on either side of the windows.

Unfinished small work and usable bits of wood are kept in a swinging drawer beneath the bench. Metal scraps are kept separate from the wood and deposited in a keg or box under the bench.

A tilting trash box, with a metal lip like a huge dust pan, facilitates sweeping and supplies the air-tight stove with plenty of fuel in cold weather.

On Saturdays the boys of the neighborhood —and there is an astonishing number of them



One of the tool racks and the trash box, which can be laid down to receive all the sweepings.

—have the run of the shop. On these occasions sad experience has made clear the advisability of locking up the best tools in a wall cabinet, for some of the younger craftsmen have no inhibitions about using a chisel for a screw driver or in cutting off nailheads with a plane. Among the tools are a number of "seconds," which are always placed at the disposal of the boys.

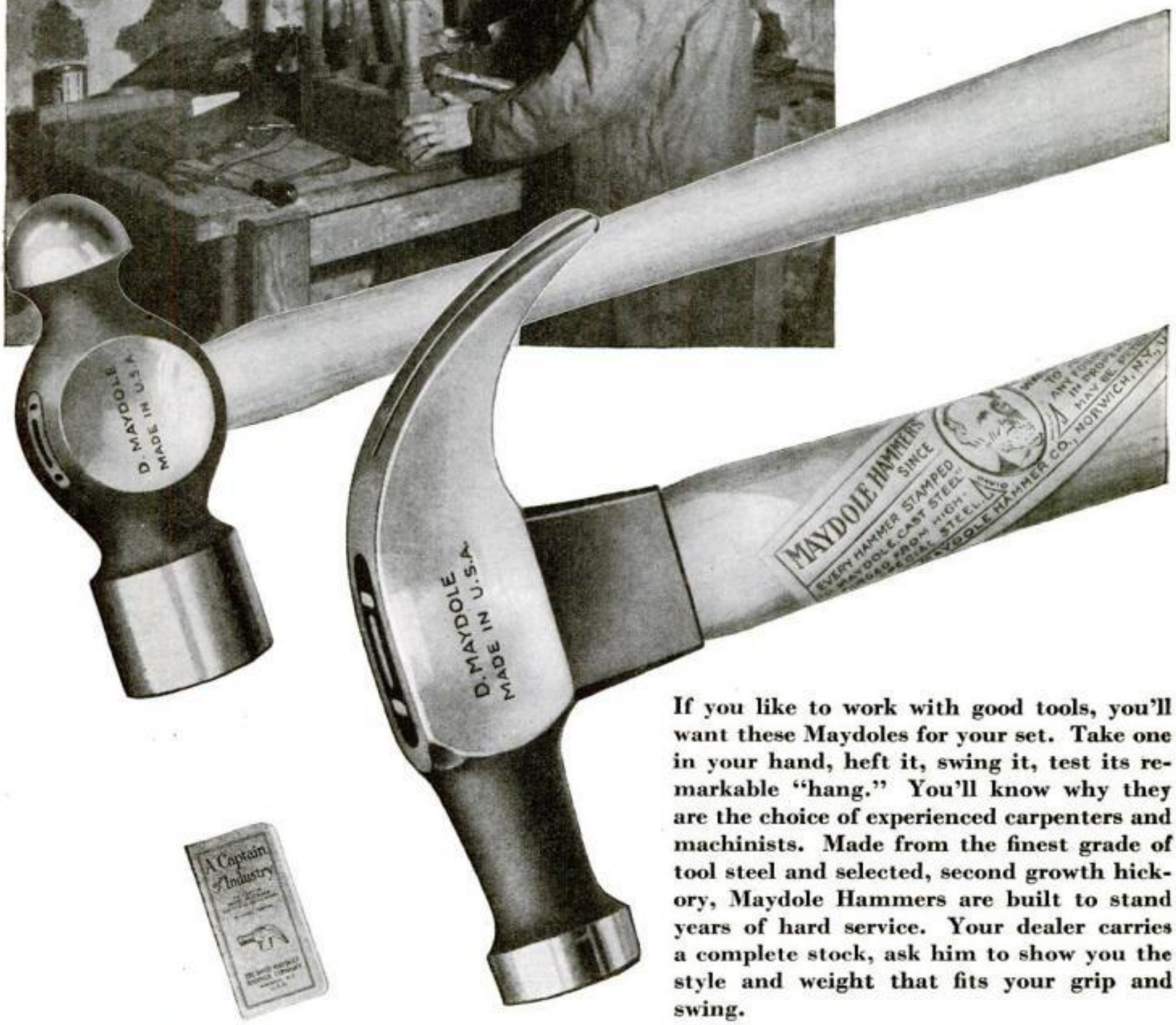
The many useful things produced in this shop would make a formidable list; there have been scores of them, from tiny boats to substantial pieces of furniture. About half the time has been required to construct these items as would be the case under ordinary conditions where the tools and materials are not so handy. When there is a call for minor repairs about the house, the job is done quickly by virtue of having everything necessary within immediate reach.

Fruit Jar Rubbers Prevent Rugs from Slipping

THE slipping of rugs and carpets on polished floors can be prevented by sewing fruit jar rubbers to the underside. A rubber should be placed at each corner and, for large rugs, one or more placed along the edges. The rubbers also tend to keep rugs from turning up.—W. E. BURTON.

METAL gutters that leak can be patched temporarily by cleaning the defective area with sandpaper or a wire brush, painting it, preferably with roofing paint, and applying a piece of canvas which has been soaked in paint. When this is dry, apply another coat of paint.

Build it with a Maydole



Write for a free copy of Pocket Handbook 23 "B" which contains many valuable tables and much useful information.

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2558

Chests in Popular Designs

(Continued from page 80)

more suitable for machine fitting than hand work.

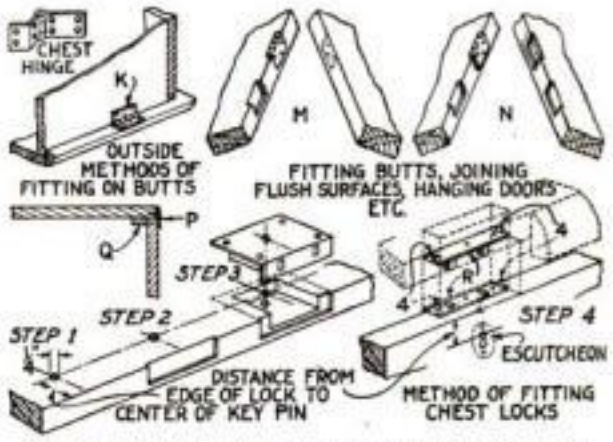
Dowels may be located by driving small brads about halfway in one of the edges to be joined at the points where the dowels are required and cutting them off so as to leave about ⅛ in. projecting. Carefully place the two boards together and rap them sharply with a mallet. Separate them and pull out the brads. The small holes will be in perfect alignment and will indicate where to bore the dowel holes in both edges.

After the boards have been glued, plane them roughly to a straight surface and to an even thickness at the ends. Select the face sides of all pieces, joint the best edge of each, mark and saw the lengths accurately with a fine saw, and plane the parts to accurate widths.

The Colonial chest illustrated is assembled by fastening the end pieces to the sides with 1½-in. No. 9 screws and hiding the screw heads with plugs. Bore a ⅞-in. hole as at *A* ¼ in. deep, and drill a ⅜-in. hole the rest of the way. Make the plug by sawing ½ in. from the *end* of a ½-in. board and planing, whittling, or filing it round and tapered so it can be driven closely into the ⅞-in. hole. Drive the screw; then glue and set the plug in the hole. The grain of the plug should coincide with the grain of the surface. Later on the plug can be trimmed flush with the board.

Chests may be assembled by several other methods shown on page 80.

In the high chest, the open dado joint *B* is assembled by means of 1½ No. 8 screws driven



A chest hinge; various methods of applying butt hinges; the steps in fitting a chest lock.

a little slantingly. The countersunk screw holes and the joint are covered with a strip or truss.

In the Hepplewhite chest, the dado or milled corner *C* requires the use of a circular saw; the grain at *1* is a weak place. The half-and-half joint at *D*, nailed two ways and with the nails set and the holes filled with putty, makes a good joint. The mitered and splined joint *E* is the best joint shown; it is strengthened by splines *2*, made of veneer and glued into slanting saw cuts of suitable width.

The construction of the seat chest permits a simpler form of corner. The sides and ends may be securely nailed as at *F*.

A chest bottom should be perfectly square and fastened to the bottom with sixpenny finishing nails or with 1¼ No. 9 screws.

The trusses and feet may be made from ¾-in. pieces cut larger than required, glued together, sawed, and the curves smoothed with spokeshave, file, and sandpaper. Fasten these in place with glue and with nails or screws.

Handles may be made of ⅞-in.-thick wood hollowed underneath and fastened with glue and screws.

Make the cover ⅛ in. larger all around than the body of the chest, with square edges and true angles. The (Continued on page 130)

Ⓢ This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

A definite program for getting ahead financially will be found on page four of this issue.

Chests in Popular Designs

(Continued from page 128)

molding *H* (Colonial chest drawing) around the cover is ⅞ by 1½ in. It is fitted to the edge, mitered, and fastened with glue and sixpenny finishing nails. Place the glue in the middle of the end as at *G*, which will allow the cover to shrink and swell without twisting. Take the same precautions in fastening cleats *J* with glue—that is, apply the glue only at the center—and have the screw holes fit the screws loosely. The edge of the cover should project 1 in., but it may be ⅛ in. less so that *H* will just clear the body of the chest.

REGULAR chest hinges, which have one leaf offset, as shown in the upper left-hand corner of the drawing on page 128, are ordinarily used. The offset leaf is attached with screws to the upper edge of the back of the chest and to the inner surface of the back. Hinges of this type can be obtained at the larger hardware stores and manual training supply houses.

Ordinary butt hinges *K* also can be used and, of course, are obtainable anywhere. To apply them, lay the cover and chest upside down; place the butts and drive the screws while in that position. If the cover and back are flush, the hinges may be placed as at *P*. In that case, a strip ½ by 1 in. in cross section should be fastened to the inside of the cover as at *Q* to make the joint tight

Fasten a piece of chain, strap, or webbing about 18 in. long from the chest to the cover, inside, to prevent the cover from falling too far back.

Butts placed at *L* in the drawing of the chest seat may be cut entirely into the cover (as shown at *M* in the drawing on page 128) or one half their thickness may be set into the cover and half into the back piece, as at *N*.

Fit the chest lock by following the steps illustrated. Place the striker *R* in the lock and turn the key; drop the cover on the striker and the points *4* will mark the underside. Raise the cover, place the striker in the marks accurately, and mark carefully around the plate with a knife. Sink the depth of the plate until the cover will be held firmly when the chest is locked. After the chest has been finished, the escutcheon may be fastened in place.

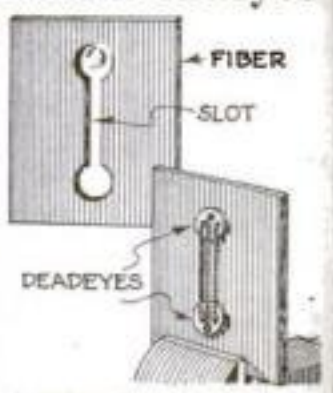
The chest may be finished on the outside in its natural color or stained. Give the wood two coats of shellac and two of rubbing varnish or rubbing lacquer. Rub the undercoats with No. 4–0 sandpaper, and if varnish is used, rub the last coat with powdered pumice stone and oil. Do not finish the inside in any way or the aroma of the cedar will be destroyed.

Some manufacturers sell knocked-down cedar chests in a variety of designs. These usually have finely machined corner joints so that the parts practically lock together. Their assembly is, therefore, a simple matter.

Manual training supply dealers and stores which carry hardware specialties often have on hand a supply of special hardware for chests, including copper bands, corners, hinge plates, escutcheons, handles, and chest lid supports.

Rigging Ship Model Deadeyes

A VERY simple method of lacing deadeyes together for ship models is to use a form made as shown from a small piece of fiber board. Drill two holes the size of the deadeyes and cut a slot between them to allow the deadeyes to be removed after they have been laced together.—D. W. CARR.



Fiber form is aid in lacing tiny deadeyes.

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(Write in Pencil—Ink will blot)

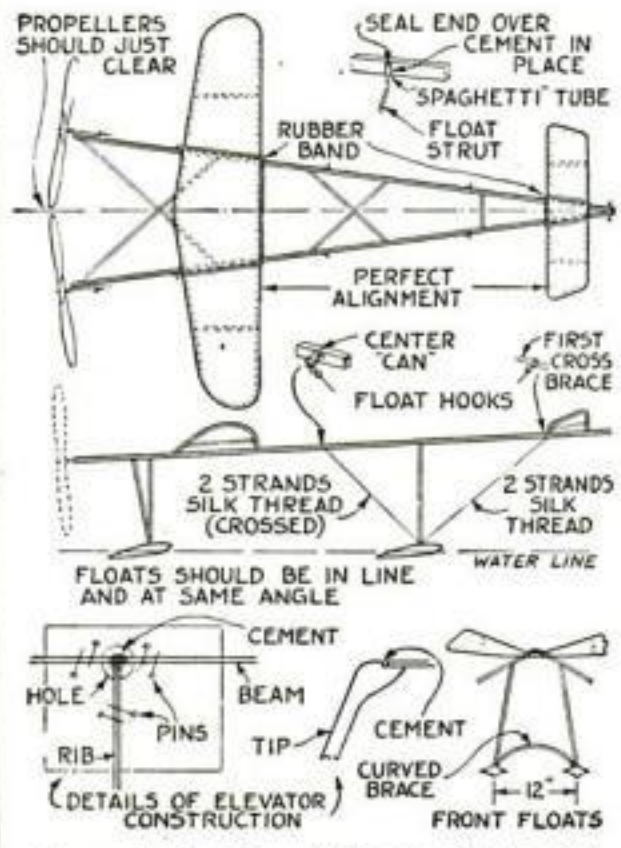
A Record-Breaking Model

(Continued from page 106)

and tie them to their small hooks, which are anchored on the center "cans" on each side. Be sure that the rear threads are drawn up snugly without being tight. By using this socket method, you can assemble the hydro part of your model in a few seconds.

Remember that your model will perform considerably better without floats provided you readjust the locations of the planes to secure the correct flying balance.

To fasten the wings in place, use fairly strong strips of rubber or rubber bands. Unless a strong band is used on the elevator, the model



Top and side views of the assembled model; how the front floats are attached; method of pinning elevator parts to cardboard.

may fly in an eccentric way because the elevator shifts and twists slightly at will.

The propellers should be threaded around through the bearings so that when they are in their proper position they turn up through the center and down on the outside—in other words, the right-hand propeller turns clockwise when viewed from the rear.

String up two 10-strand motors *N* so that they are the same length and neither has very much slack. Slip these motors on to the S-hook and shafts.

Find a place—preferably where there is tall grass—and glide the model by holding it level with your shoulders on an even keel and pushing it positively but gently into the air. If the nose drops quickly to the grass, either you have not launched your model fast enough or the elevator and the main plane should be moved slightly forward. Be careful to do your gliding where there is nothing to puncture your wings or floats. Be sure to inspect your floats before going out on the water with the model.

When a good gliding setting has been obtained, so that the model sails along without much stalling, you have found the suitable trial setting for flying the model.

Do not send your Morris model out across a lake unless you have a motor boat of some kind to follow it, as perhaps it will fly with the wind considerably faster than you can follow it with a rowboat.

The hydro model should always take off from the water facing the wind or with its nose straight into the wind. For a trial flight, 125 turns with the 5-to-1 "egg beater" winder will be required on a calm day to get off the water quickly, and 100 turns will be required on a day when there is a little breeze and ripples on the water.

(Continued on page 134)

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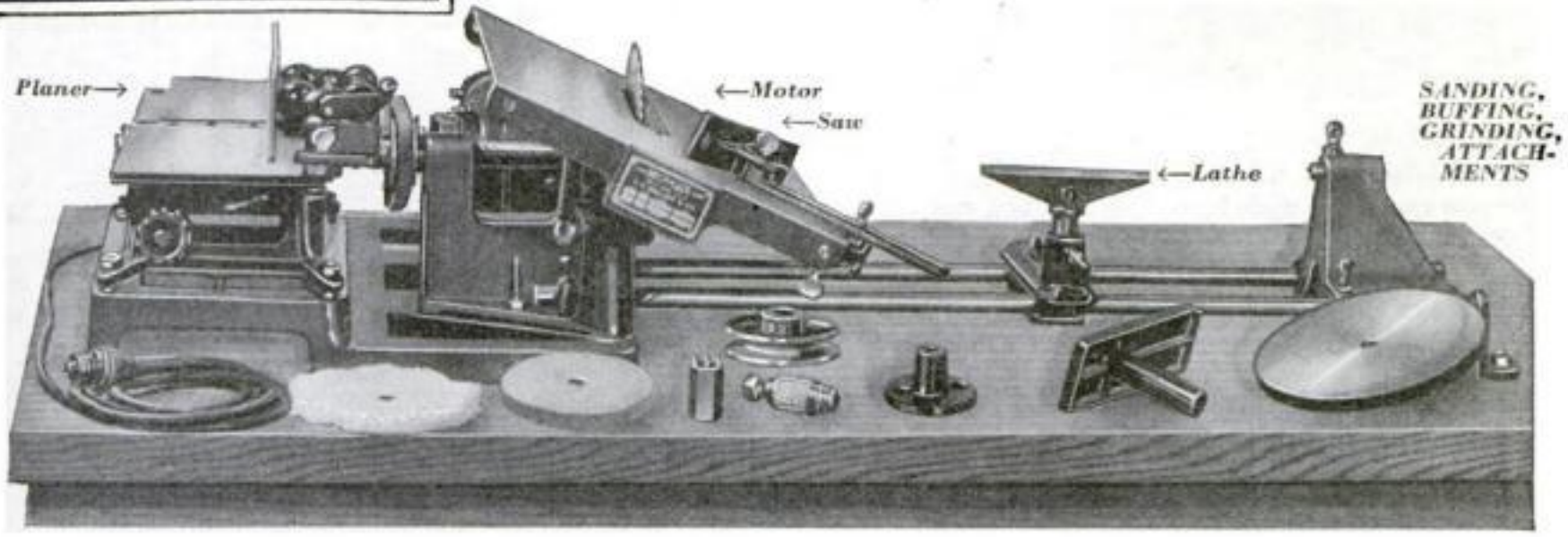

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Our terms are all in your favor, a new and revolutionary method of purchase. Many pay for their Workace Shop out of the profits it makes . . . A small down payment brings the Workace complete and ready to set up for immediate use. The monthly payments are so small you'll scarcely miss the money . . . Send the coupon now—today—and we'll see that you get full details and a complete description by return mail:

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Endless V. Belt, two 4" and one 2¼" V Belt Pulleys, Cast Iron Sub Base and 10 ft. Cable with separable Plug. The Planer and Circular Saws are each complete units and may be purchased separately at the correspondingly low price of $25.00 each.

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That Workace Electric Woodworker sure looks good to me. I want to know ALL about it, including your easy terms, right away.

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A Record-Breaking Model

(Continued from page 132)

It is taken for granted that you know how to stretch out the rubber before winding and walk in as you wind. The winding is done with the rubbers outside of the cans; and when the rubbers are fully wound, the S-hooks are transferred from the winder to the front hook on the frame, and the rubbers are slipped in the opening in the cans. A helper will be required for the winding. It is best to wind the model on land, but it can be done in a boat, providing the holder is at one end and the winder at the other end of the boat.

IF THE model can be launched from an inland pool, your problem is much simpler. Set the model down on the water, holding it only by the propellers and frame at the rear. Be careful not to put too much strain on the frame. In case a puff of wind catches the wing and tries to swing the machine around, let it do so by all means, for otherwise the frame or the wing will probably be wrecked. Then swing the machine back, edgewise to the wind, and set it in the water.

If the model does not weigh very much over 3 oz., you will find that it will hop right off and sail away through the air. It will give you a real transoceanic thrill, making you wonder whether your model will beat Morris' record.

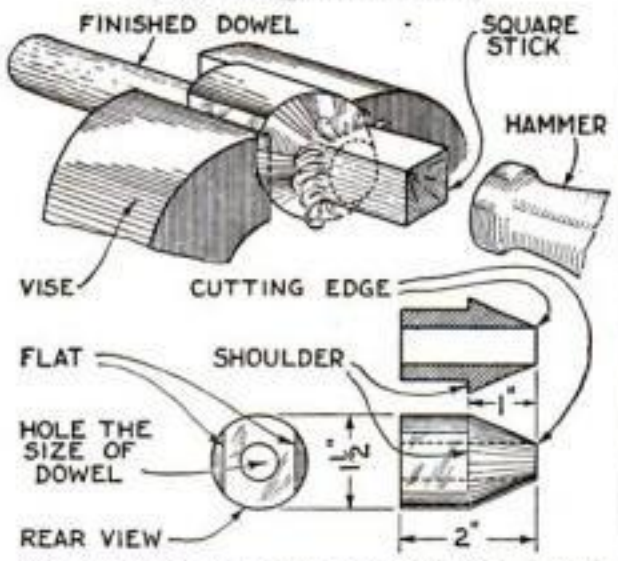
You can tell from the performance of the model in this trial flight whether it is over- or underelevated, and adjust the wings accordingly. If it is very slightly overelevated, you have the ideal setting, as this will not bother you when your motors are fully wound. Now hurry up and recover your model before it gets lost from sight or some other boat runs over it.

Occasionally the model turns upside down in landing, so that you may have only three little floats sticking out of the water to look for. In case your model flies over land after taking off from the water, you should have a bicycle or an automobile to follow it.

For a contest, use new rubbers which you have previously stretched about four times their length, prewound 1250 times on your 5-to-1 winder, and then allowed to unwind. You should not put more than 200 turns in the motors; beyond this point they are apt to break and become inefficient.

Let's go, now, and see how close we can come to Morris' enviable record!

Sharp Edged Cutters for Making Dowels



A heavy steel cutter for preparing ½-in. dowel sticks; other sizes can be made in the same way.

BECAUSE of their sharp cutting edges, dowel pin cutters like that illustrated will make long wooden dowels almost as accurately as a machine. The wood is merely driven through. Any size desired may be made in a few minutes by a machinist. The dimensions given are for a ½-in. hole.—R. C. STANLEY.

A definite program for getting ahead financially will be found on page four of this issue.

Bad weather is SORE THROAT weather

Gargle when you get home

As soon as nasty weather sets in, thousands are down with sore throat, colds, grippe, flu or worse.

Don't be one of them. Gargle with Listerine full strength every day—especially after exposure to rain, severe cold and coughing crowds in public places—buses, street cars and movies. This simple act may spare you a costly and possibly a dangerous siege of illness.

Because Listerine, full strength, is powerful against germs—and sore throat, like a cold, is caused by germs.

Repeated tests show that Listerine kills even the stubborn B. Typhosus (typhoid) and M. Aureus (pus) germs in 15 seconds.

Realizing Listerine's power you can understand its effectiveness against the milder winter complaints caused by germs. Each year increasing millions rely on it.

Keep a bottle handy and at the first sign of trouble, gargle repeatedly. Don't hesitate to use it full strength. It is entirely safe in any body cavity.

If a throat condition does not rapidly yield to this treatment, consult your physician. Lambert Pharmacal Company, St. Louis, Mo., U. S. A.

Two ways of whipping a cold

Colds usually start in the nose and throat as a result of germs already present there or carried there by food touched by hands.

As a precaution against colds and sore throat, the use of Listerine full strength as a hand rinse before meals and as a mouth rinse and gargle every morning and every night, is most effective.

When a cold or sore throat has already started, more frequent use of full strength Listerine is advisable. Its ability to get results lies in the fact that it is so powerful against germs. Don't hesitate to use it full strength. It's both healing and soothing to the tenderest tissues.

LISTERINE

THE SAFE ANTISEPTIC

Answers to Questions on Page 55

1. Burning is a chemical action carried on at a rapid rate. The oxygen in the air unites with the material that is on fire to form other compounds. When the action takes place quite slowly it is called oxidation, instead of combustion or burning. The drying of paint, for example, is an oxidizing process in which the oxygen slowly combines with the linseed oil. The rusting of iron is another example.

2. Small brown lumps form on the roots of leguminous plants. These lumps contain bacteria of a type capable of converting the nitrogen of the air into nitrogen compounds which fertilize the soil. Even after the plants die these bacteria keep on enriching the soil.

3. A warm solution of sodium hydroxide (caustic soda in water) will dissolve wool fibers but will have little effect on cotton fibers. If a piece of cloth is immersed for ten minutes in a warm two-percent solution of sodium hydroxide, it will be completely dissolved if it is pure wool. Any cotton fibers used to adulterate the wool will not be affected.

4. Sulphuric acid has a powerful affinity for water. In fact, if a large-mouthed bottle of concentrated sulphuric acid is allowed to stand uncorked, the level of the acid will slowly rise as water is absorbed from the air. Storage battery acid is sulphuric acid diluted with water. When this solution is spilled on cloth, the acid attacks the fibers and robs them of their hydrogen and oxygen to form water and thus, in time, destroys the strength of the cloth.

5. Hard water contains calcium compounds. Soap dissolved in such water forms, with the calcium compounds, a curdlike substance. If enough soap is used to precipitate all of the calcium compounds in the water, any additional soap used will form lather in the usual manner.

6. Marsh gas is formed from decaying vegetable matter. It is principally composed of methane. It burns with a blue flame. The bubbles that rise to the surface when you prod the muck at the bottom of a stagnant pool are largely methane.

7. Steel, cast iron, and soft iron differ only in the amount of carbon they contain. Soft iron contains practically none. Steel contains a small percentage of carbon. Cast iron contains a relatively large percentage of carbon.

8. Both the yoke and the white of an egg contain sulphur compounds which, during decay, are converted into hydrogen sulphide. This gas has the characteristic bad egg odor. Other odorous foods, like garlic, cabbage, and onions, also owe their nose-offending qualities to various sulphur compounds.

9. Cloth burns because the oxygen in the air combines with the hydrogen and carbon of which the cloth is composed to form water vapor and carbon dioxide. This process can be greatly retarded by coating the cloth with a substance which will protect the cloth from the oxygen. This can be accomplished by dipping the cloth in a solution of ammonium phosphate in water and then letting it dry. The ammonium phosphate forms a fireproof coating over the cloth fibers. Other substances such as alum, borax, and sal ammoniac have somewhat the same action.

10. Baking powder used in all leavened bread is composed of bicarbonate of soda and a mildly acid substance such as cream of tartar. When the dough is heated by baking, the bicarbonate of soda is changed to carbon dioxide, which is a gas, and to carbonate of soda (washing soda). The acid substance reacts with the carbonate of soda to neutralize it, and the carbon dioxide bubbles inflate the dough and thus make it rise.

How Your Car Gets Its Spark

(Continued from page 84)

Inside the coil is a core made up of a bundle of iron wires. When you treat iron that way it becomes a magnet, just as it does in a doorbell.

"All you do with the juice from the battery," Gus continued, "is to make the core of the coil magnetic. And after the current has magnetized the core you cut off the juice by opening the contacts in the timer.

"Now comes the part that seems mysterious but really isn't. Wound on top of the coil of heavy wire are thousands of turns of very fine wire. That's called the secondary. One end of the coil is grounded on the frame of the car. We'll show that by a dotted line. The other is connected to an insulated metal finger that turns around inside the distributor head, making and breaking a series of contacts. Each one of the contacts in the distributor is connected to a different spark plug.

"WHAT actually happens is that we make the core magnetic by using the juice from the battery, and then we use that magnetism to generate the high voltage current. Magnetic lines will create a current in a wire whenever you move the wire across the lines. In a regular dynamo, you move the wire. In a spark coil the wire stays still and the magnetic lines move like lightning when the primary current is cut off."

"Why do you need so many turns of fine wire? I should think the magnetic lines would have more effect on heavy wire," Harnett interrupted.

"What you want is plenty of high voltage, and the voltage generated depends on the number of turns, not on the size of the wire," said Gus.

"Seems simple enough," Harnett admitted. "Now, if it's not asking too much, I'd really like to know why your price for overhauling the ignition was so much higher than the other fellow's. I know you'd do good work, but what is there to do besides cleaning the spark plugs and filing and adjusting the contact points?"

"There's lots more," replied Gus. "First I'd want to test the little spring that holds the contact against the cam and put a new one in if it was getting weak. Then after I got the timer in bang-up good shape, I'd want to put in all new high-tension cable between the distributor head and the spark coils. Yours is old and cracked and leaks juice all over the place when it gets wet. If you don't believe it grab one of the wires on a rainy day while the motor is running.

"Then, of course, I'd want to test the distributor and make sure it wasn't leaking, and after that I'd go over the spark plugs, replace the bad ones, test the spark coil, and then inspect every single connection. When I got through, your ignition would be just as good as when the car left the factory—and maybe a bit better!"

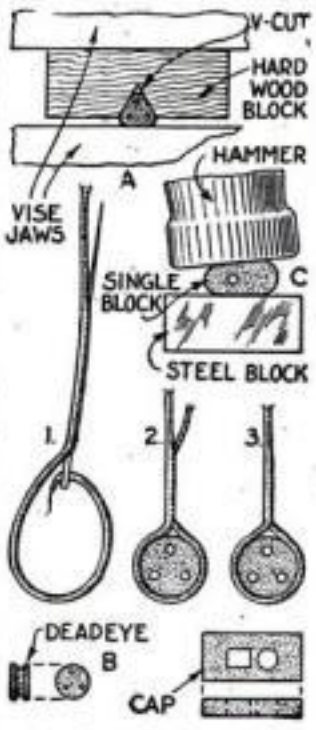
Have you some motor problem or experience you think would interest Gus and Joe? Let's hear about it. The Model Garage is always open, and its genial proprietors grow more popular every month.

Model Deadeyes and Blocks Made of Leather

SHIP model builders can save much time and work in making deadeyes and blocks by the following method:

With an ordinary leather punch of the size desired, cut several blanks from a piece of sole leather. The kind carried by shoe repair shops is generally too thick, but it can be reduced to the desired thickness with a sharp plane.

Do the trimming on the inside or rough side of the leather. If heart shaped deadeyes are desired, press them in the shape shown at *A* and drill the holes after they are shaped. Round deadeyes are left in the original shape *B*. Blocks may be given an oval appearance by tapping them with a hammer on one side while they are held firmly against a hard surface as at *C*.



Leather fittings and a simply made splice.

The holes should be drilled with as small a drill as possible and the groove cut around them with a three-cornered file after they are shaped and drilled.

To fasten them to the rope, use a cord of tubular weave, such as some fish lines, or a waxed harness thread, and splice them as in the steps marked 1, 2, and 3. Shellac the joint well to fasten it. This method gives them the appearance of a splice and does away with the undesirable knot.

Leather may also be used for crosstrees and caps.—JOHN MCGLASSON.

Veneering Isn't Hard

(Continued from page 90)

Cut strips of veneer ¾ in. wide and glue them around the joining edges of both box and cover. Gently rub each piece in place, after all are cut and fitted, with the flat face of a hammer. This must be done rapidly.

Glue the box edges first, for example, and place a piece of paper and a caul on the veneer and weigh it down while the veneer is being placed on the cover. Remove the weights from the caul and place paper and the cover upon it as shown at *J*. Apply hand screws with moderate pressure, and allow the work to set. Later trim and sandpaper the edge veneers.

Hang the cover with ⅜-in. narrow butt hinges or place small butterfly hinges on the back; the latter is by far the simpler. Cut in a small lock or catch, although either would be more ornamental than useful.

Make the tray about 3/16 in. smaller than required to allow for the velvet lining which should cover the inside completely. Make the tray of 3/16-in. wood with butt joints throughout. Plane the front face of the tray back on a slight angle as at *K* to allow the cover to close without striking it.

Finish with three or more thin coats of shellac, rubbed with No. 4/0 sandpaper between coats, and polish with wax.

IN WASHING off old kalsomine the handy man occasionally experiences difficulty. An expedient used by painters in similar cases is worth trying. Dissolve one pound of alum in one gallon of vinegar and apply it to the surface. Let it stand for ten minutes and wash the kalsomine off with water.

A Famous Sky-Writer Tells of His Job

(Continued from page 31)

combinations of the letters are too difficult.

Pilots particularly dislike the script letter "m." The last two loops have to be added, one at a time, without disturbing the part of the letter already written—no mean job. A capital "E" requires a bothersome number of loops. Of course, an "I" is the simplest of all.

By all odds the easiest sky-writing we ever had was in England, weaving the word "OXO," a trade name. And the curious part was that besides having simple letters—"O's" and "X's" are no trouble at all—it could be written forward or backward, right-side up or upside down, and it would still read the same. We were congratulating ourselves on the performance of a "cinch" order when someone telephoned and wanted to know if we were playing "Tick-Tack-Too" in the sky.

The planes we use are speedy little fighters—wonderful craft to pilot, but so tiny that you need a shoehorn to ease yourself into the cockpit. They can fly at 135 miles an hour and climb 10,000 feet in twelve minutes. On the joy-stick is the smoke trigger—a small lever resembling the catch on an automobile hand brake. Press it, and a puff of smoke issues from the tail of the plane and continues in a steady stream as long as the lever is squeezed.

THE smoke comes from liquid chemicals stored in pressure tanks in the fuselage. Wind-driven pumps keep up the pressure. When the smoke-trigger is pressed the liquids spurt into two elongated asbestos-covered pipes from the motor, one on each side of the ship. They're hot as blazes from the exhaust and the heat vaporizes the chemicals. Shooting out with the force of the exhaust, they mix, where the pipes converge, in a tube a foot in diameter that opens just behind the rudder. Smoke belches out at the rate of about 250,000 cubic feet a second and immediately spreads out to form a fuming rope in the air about thirty or forty feet thick. From the ground it looks flat, like a ribbon.

We've tried smoke of different colors—green, red, yellow. But white smoke stands out best against a blue sky.

Suppose I am going to sky-write over a city. The sky is blue and weather reports say the wind overhead is light enough to avoid an excessive drift of the letters—a combination that doesn't happen as often as we would like! My plane is tuned up and I slide into the cockpit. My printed chart is on the dashboard, for I have been practicing what I am to write. A mechanic swings the "prop" and a roar comes from the eight cylinders of my 200-horsepower motor. I press the smoke-trigger to make sure the smoke is working O. K. before I take off. It is. I soar into the air.

A HALF-HOUR'S flight, perhaps, and the city is beneath me. I climb in a wide spiral. With the sun toward the south, I must write well to the north of the city so people can read it without being blinded—and so the smoke letters will be etched against the blue sky instead of blending with the whitish haze of the southern heavens. The wind is from the west, so I start writing far enough westward for the letters to drift over the city by the time I am through. I always write *into* the wind, otherwise the letters would spread out too much.

Is the wind steady—that is, free from eddies that destroy the fragile letters? The fellow who's paying $500 or $1,000 to have me write in the air has a right to expect his message to last a few minutes at least—so I occasionally let loose a spurt of smoke to see how it will "hold" in the wind.

At 10,000 feet I find the letters remain intact, even though they drift for ten or twenty miles. In fact, most of our writing is done about two miles high, where (Continued on page 139)

A Famous Sky-Writer Tells of His Job

(Continued from page 138)

the wind is steadiest. Also, it gives everybody in the city a chance to read. I would say the usual sky message is read by millions in a thickly populated area as large as fifty square miles.

With the sun on my left and the wind in my face, I press the smoke-trigger and commence to write. I can't see them, but I know that upturned faces in the streets below are watching. To them my plane is so small that it is almost invisible, except when its wings gleam like silver in the sunlight.

No time for "monkey business" now. The whole word has to be done in the quickest possible time; it will only last from five minutes to half an hour, depending on the wind. This is a long word and takes eight or nine minutes to write, but I think it will hold at this level.

Speed! My little plane stands on a wing-tip as I loop around a script "l." Now I'm tearing along straightaway, with a trail of white smoke in my wake. The air's a bit bumpy, but it won't show from below. We always write on a flat plane, though the letters may look vertical from the ground.

WOULD you believe I flew fifteen miles to make one letter? Now I've got to go back a couple of miles to dot an "i." That dot is as big as a city block. We write on a grand scale, you know—with capital letters a mile long, generally, though sometimes the client wants them even larger and we do our best to please him.

Watch me cross this "t" and you'll learn a sky-writing trick. See? I zoomed over it at a safe distance. If I'd flown straight through I'd have blown the letter away. From the ground you'd never know the difference.

There's the last letter done! All through, for better or worse. Now we'll dive 1,000 feet and take a look at what we've written. The pilot has the worst view of anyone while he's writing. All he can see is the nearest plume of smoke to show where to hitch on a letter's tail. He can only pray that the rest are all right.

Looks pretty good. Well there's a day's work done. Back to the field!

If a sky-writer can't see much of what he's doing, how does he know when to twist and turn? If you'd practiced a word as often as I have you could write it blind. You get so mechanical that if you ran out of smoke you'd just go on tracing letters without realizing it, as Collyer did. Of course, the first time you're careful to jam over the rudder at the right moment for each letter. After a few tries it's old stuff. And you have your chart to guide you.

One of the few flyers I know who can put on a show on the spur of the moment, without practicing, is Captain Turner. That Briton can go up and tear off a word or two just as naturally as using a fountain pen to sign his name.

A WORRIED woman asked me once if sky-writing wasn't dangerous. "What would you do," she said, "if your engine stopped and you had to come down? You couldn't land on a building, could you?"

I'd hate like the dickens to try! But there's really no danger. Flying two miles high, if anything went wrong I could glide to the landing field fifteen miles away—though no one I know ever had to do it. For an emergency there's a parachute in every plane and any sky-writer will tell you it makes a comfortable seat.

Every now and then we get a queer order. For instance, a woman offered us $10,000 to sky-write a New Year's greeting to New York, with her name added to it. We turned that one down, as we did the request of an Italian Society to sky-write "Sacco-Vanzetti" during the trial of the two men that aroused nation-wide comment.

We didn't welcome (Continued on page 140)

A Famous Sky-Writer Tells of His Job

(*Continued from page 139*)

the Prince of Wales, but we did sky-write a greeting to Lindbergh when he returned after his epochal Atlantic flight. "HAIL LINDY" we wrote. "Welcome" would have used up too much smoke. But we had enough left to add the initials "Q. B.," for the Order of Quiet Birdmen, of which "Lindy" is a member in good standing.

No one to date has chartered a sky-writer to send a farewell message to a voyager leaving this country—though Captain Turner and Captain Collyer once staged an impromptu show along that line. Major Savage, inventor of sky-writing, was leaving for England; and Turner and Collyer pursued his ship. Circling above it, they wrote "CHEERIO." Then they raced around the ship to surround it with a halo of smoke clouds—all in the spirit of fun, but much to the consternation of Major Savage, who feared something might go wrong with their plane and they would fall into the sea.

THE world first saw sky-writing in England. Some years previous—before the World War—Major Savage had conceived the idea that a skilled aerial acrobat might be able to write smoke letters. But it was not until after the War that he perfected the smoke-producing mechanism to do it, and formed a company to exploit his invention. The company was about broke, with no takers, when Lord Northcliffe, British publisher, signed the first order to write the name of his London newspaper, the *Daily Mail*, in the sky as an advertising stunt.

The feat was accomplished during the historic races at Epsom Downs, the Derby course. Two million spectators saw Captain Turner, a distinguished war flyer, take the first sky-writing plane into the air. As the words "Daily Mail" were spread in the sky the usually phlegmatic Britishers loosed a spontaneous cheer.

Today, sky-writing is a world-wide enterprise. Hundreds of "shows" have entertained Americans from the Atlantic to the Pacific, from Canada to Mexico. Many of the pilots who stage th n are "war birds" like myself. They go at eir work in a methodical, systematic w —though a good sky-writer secretly fee pride in a literally "well-turned" phrase.

And may they always have a nice blue sky to write on, a wind that is steady and low to keep their letters intact, a short name to write —and plenty of smoke!

When the Sun Grows Cold

(*Continued from page 35*)

of the very heavy and very rare elements," he said. "More than ninety-nine percent of all matter consists of atoms of atomic weight less than 100. Recent discoveries seem to prove that no element of lower atomic weight than that can disintegrate with the evolution of energy. Therefore radioactivity, with the ejection of even a feeble amount of energy, is not a property of all matter, as many of us have thought it might be."

HE RIDICULED the dream of utilizing atomic energy as a source of power when the coal is gone. "Energy available from that source may be sufficient to keep the corner peanut and popcorn man going, on a few street corners in our larger towns, for a long time yet to come, but that is all," he said.

As to what is going on in outer space Millikan had an unfamiliar conclusion to offer. Alongside the annihilation of the celestial bodies through radiation there is a process of element building of vastly greater extent and importance. (*Continued on page 141*)

When the Sun Grows Cold

(Continued from page 140)

"The great majority of elements, such as constitute the bulk of our world, are in their state of maximum stability already," he said. "They have no energy to give up in the disintegrating process. They can only be broken apart by working on them or by supplying energy to them. Man probably can learn to disintegrate them, but he always will do it by the sweat of his brow."

ATOM building as a source of energy is a matter to which little consideration has been accorded. "Recent experimental work on cosmic rays has just thrown a flood of light on the processes going on in the universe in which we live," said Millikan. "My associate, Dr. Cameron, and myself have recently found three definite cosmic ray bands, or frequencies, of penetrating powers as high, in one case, as a hundred times the maximum possible energies that can be obtained from any disintegrating process. Two or three inches of lead absorb the hardest gamma rays of the X-ray; one of the bands of cosmic rays we found has such enormous penetrating power that it passes through as much as eighteen feet of lead before becoming completely absorbed."

"Where do these rays come from and what are they?" I asked.

"They are signals broadcast throughout the heavens of the birth of common elements out of positive and negative electrons," said Millikan. "Helium, oxygen, silicon, and iron are being manufactured in space out of hydrogen and, possibly, in the case of silicon and iron, out of helium. And this process involves very much greater energy-changes than any occurring in radioactive processes.

"As to where these changes are going on it is definite, I believe, that they are not occurring in the stars. While a continuous atom-destroying process is taking place under the extreme conditions existing in the interior of the stars, an atom-creating process is continually taking place under the equally extreme conditions of just the opposite sort existing in interstellar space. And the rays or energy-streams given off in this process come to the earth at all times practically uniformly from all directions."

"WHAT becomes of the new atoms thus created?" I inquired.

"They find their places in the stars, including our sun, to replace the atoms destroyed by disintegration," said Millikan. "In other words, our universe is constantly rebuilding itself; atoms disintegrate and shoot off electrons into space, where the electrons recombine again, chiefly into the four essential elements of hydrogen, oxygen, silicon and its immediate group, and iron. Those are the only abundant elements. Man, a billion years hence, will be satisfying his main needs, as he satisfies them now, with those four elements in varying combinations.

"The energy supplied to man has all been from the sun and a billion years hence he will still, I think, be supplying all his needs for light, warmth, and power entirely from the sun. There are numerous effective ways of utilizing solar energy which we have not yet adopted merely because we have not needed to use them so far. They will be available so long as the sun continues to supply the earth with energy."

"But the sun also is disintegrating, like the rest of the stars," I objected. Millikan smiled.

"New suns are being built from electrons given off as the old sun disintegrates," he said. "When its matter has all been stoked into its furnaces, and they are gone out altogether, another sun probably will have been formed, so that on this earth or some other—it matters not which—some billion years hence the development of man still may be going on."

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booked to speak on September Eighteen, 1901.

The anxious younger brother, between spells of tending customers at the bicycle shop, rigged up a new device of his own to measure air pressure on plane and curved surfaces.

"Great guns, Lilienthal is right after all!" I hear Orville mutter in horrified accents after a hasty check-up on the new device of a few figures from the German's air table. "Nearly right anyhow. I must let Will know before he tells those scientists what isn't so!"

Wilbur, astonished and pained by this home work, dutifully squirted water on the fireworks of his Chicago speech. The audience applauded a soggy and safe utterance. On the speaker's return home he sadly agreed with Orville that the address in printed form would have to be made yet soggier and safer. So was it done.

THE brothers had to eat humble pie for a time after Wilbur's Chicago address. They had gone too far; they had had to retract. Then one morning in the bicycle shop laboratory, checking up again those air tables with their homemade apparatus, we can hear glad cries rising above a racket and roar:

"Will, just look at this dial!"

"Orv, that's great!"

"Maybe we're right after all!"

"You just tested a few of Lilienthal's figures before and they happened to be nearly right. This shows the table as a whole is sway-backed, knock-kneed, and cross-eyed. Hurrah!

They felt, perhaps, a greater thrill than when they took their first rides on a glider at Kitty Hawk—not because they had found error in a predecessor, but because they had found a sure and accurate method of measuring air pressure on plane and curved surfaces. Perhaps they dimly surmised that they had now converted aerodynamics from a status of near-wizardry to that of legitimate and exact science, and that some day their names might be inscribed on history's roll between those of Faraday and Edison.

Professor Langley Secretary of the Smithsonian Institution and Sir Hiram Maxim had tried to measure air pressure by means of pivoted shapes attached to the end of a revolving arm. It was inherently difficult to register the angles assumed by the shapes at various speeds, despite all sorts of delicate and clever electrical apparatus. Centrifugal motion with difference of speed near and far from the center added a number of falsifying factors. The method was hopelessly complicated and full of incalculable factors. The inventor of the Maxim gun was as baffled as Langley.

THE Wrights also had fumbled the problem, though briefly, with their whirligig projecting from a bicycle. Now they were clear-eyed and saw—Orville first—that tested objects should be subjected to equal pressure on all parts, which was not the case when they were revolved around a center, and that measurement of angles should be direct and simple. Instead of moving an object through the air they would move the air on the object! That is, the test piece would be stationary except for its angle-reaction through pivots and would have a current of air driven against it. They saw that with such a method they could get the one thing needful—correct angle readings—and could dispense with all the nonessential clutter of temperature, barometric pressure, and else which had confused their predecessors.

Thus was born in a Dayton bicycle shop the world's first wind tunnel, a prime instrument of aerodynamic research now in universal use. It cost the brothers less than fifteen dollars. Savants (Continued on page 143)

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in Europe and America had vainly spent several hundred thousand dollars on apparatus of the same purpose. There was a home-made metal fan mounted on an emery-wheel shaft driven by a two-cylinder gas engine which the Wrights had built for shop power. The wind tunnel was of wood sixteen inches square and eight feet long. Objects were suspended in the air blast, and they automatically recorded by a gage pointer their angles according to velocity of the air. Old hack saw blades and stray bits of galvanized iron contributed to the measuring fixture. The apparatus was crude in every way, including its bearings. Its makers knew it and made certain compensations. Orville, in the first test, had reversed the tunnel, and now they improved sensitiveness by the simple expedient of jarring the instrument while it was in action. Pounding on the table overcame sticky bearings and gave freedom to the model wings to tell their angular stories.

MORE than 200 little wings from three to nine inches in length were tested in the wind tunnel at this time. They were of varied type and surface, and were tried out tandem and in multiple combination, as well as singly. A quick, economical, and correct answer was obtained to the question of wing number, which alone had confounded previous gliding experimenters. The model wings were cut from sheet metal, bent to desired curves, sometimes doubled for thickness and smoothed with wax where necessary. One of the discoveries which most astonished the inventors was that a thick leading edge of wing orstrut gave less resistance than a thin edge and that the important thing was to streamline the rear.

The Wrights found the true figures for the center of pressure at the various angles of a plane and curved surface. Lilienthal had indeed discovered that this pressure is at a tangent to a forward tilted wing instead of at right angles as with a plane surface, but his figures were unreliable.

The brothers also established and put into mathematical form as an important law of aerodynamics what had been a mere surmise on the part of their Kitty Hawk campmate and protégé of Octave Chanute—Dr. George A. Spratt. The medico who was thought useful to set limbs that might be broken in gliding accidents made an excellent guess when he suggested that the center of pressure under a wing did not keep moving forward toward the front edge but reversed itself at a low angle and shifted toward the rear. While Spratt thought of it first, only the Wrights were able to prove it, and without the hint they doubtless would have made an independent discovery of the fact with their wind tunnel.

THEY made two principal testing devices, the first to locate center of pressure and the second to find the ratio between lift and drift. Lift is the weight-carrying ability of a wing at a given speed, while drift is its travel in the line of motion. Scientists had vainly attempted to measure lift and drift separately and apart from each other. The Wrights recognized lift and drift as Siamese twins, which Nature itself had bonded together in a permanent union. Instead of a futile effort to separate the merry pair the brothers found a way to caliper them together, and at the same time to learn how much work each twin was doing.

"And here goes Langley's Law!" we can hear the brothers exclaim as their apparatus clearly refuted the Professor's unscientific pronunciamento that the greater the aerial speed the less the power required. At best this is a feeble half-truth. Up to a certain low range both airplanes and (Continued on page 144)

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automobiles take less power to move briskly than to dawdle. Beyond the gait of easy momentum, power must be greatly multiplied to increase speed.

"The airplane was a mere by-product of the Wrights' supreme discoveries in aerodynamics—just a useful application of their first principles of the air," says a pure scientist.

It may be so. I prefer a simpler viewpoint that their great achievement in aerodynamics contributed fifty percent to their invention of the airplane. Warping, twenty-five percent, was no laboratory find, nor was the last one quarter element of flight of which I will tell.

By February, 1902, or within four months of comparative leisure afforded by the seasonal slackness of the bicycle trade, the young amateurs had about completed their monumental research and tabulated the main results. The young amateurs sent copies of their figures, or air tables, to Octave Chanute and to Dr. Spratt. No other persons were thus favored, I believe, nor have these tables ever been published.

MEANWHILE the bicycle men, hardly realizing what they had done with their fifteen-dollar apparatus, felt a renewal of flying enthusiasm and a keen urge to test their latest discoveries in the air. They had passed the stage of guesswork in devising the size and curve of wings. They were confident that they could now build without recourse to trial and error. They had formulæ to design a glider of a size and shape suitable to carry a given load at a certain speed.

Wilbur again tackled the job of covering the wings with "Pride-of-the-West" muslin and many of the older residents of Dayton remember seeing him at work in the summer of 1902 on a foot-propelled sewing machine under the trees on the Hawthorn Street lawn. The buzz of the machine mingled with its operator's cheerful whistling of popular airs.

The brothers intended starting for Kitty Hawk in early summer, but were delayed because Wilbur volunteered to help his father, Bishop Wright, in some accounting work incidental to a controversy that was brewing in the United Brethren Church. They arrived at Kitty Hawk on August twenty-eighth. The sandy foundations of their old shed at Kill Devil Hill had settled and the first task was to lift the building, after which they extended one end to make room for the glider. The machine had a span of thirty-two feet and a depth of five feet. Its wing area was 305 square feet. The horizontal front rudder or elevator had fifteen square feet of surface. There was an innovation over their previous craft in the feature of a vertical tail, which was at first twelve square feet in area and was later cut down to half that size. The net weight of the glider was 116.5 pounds, while with an operator aboard—depending on which brother rode—the total weight was 250 or 260 pounds. The machine was stanchly built. It could be upheld by the wing tips with a man aboard.

OCTAVE CHANUTE and his medical disciple, Spratt, repeated their last summer's visit to camp. The genial and credulous Chicago engineer also had on the scene an employe, A. M. Herring, to test a couple of gliders. Herring formerly had worked for Professor Langley.

Chanute had two gliders to be tested, one a biplane and the other a multiple-wing affair. Both failed to show any merit and their designer was quite disappointed. He had seen the Wrights demonstrate their warping principle and they had sent him a copy of their air tables, but he had ignored them and designed his pair of gliders according to the principles of hit-and-miss fantasy. (Continued on page 145)

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The unpublished diary of the Wrights—which, like their air tables, should have been given to the world long ago—contains some 5,000 words on this year's campaign at Kitty Hawk. The record combines science with homely, amusing details. It is before me. Here is the substance of some lighter entries made by Orville:

Friday, Aug. 29. Kitchen fixed up and sixteen-foot well driven.

Monday, September 1. Raised building, made beds to last half a year.

Saturday, Sept. 6. Put beds at ceiling. Watched eagle soaring.

Monday, Sept. 8. Began work on glider after shooing away native razorback pigs and ending careers of two mice, one with a gun.

Tuesday, Sept. 9. Put in eight hours apiece on glider.

Wednesday, Sept. 10. Sewing and tacking wings, not a full day.

Friday, Sept. 12. Fixed ribs and wing cloth; tried top surface on hill.

Friday, Sept. 26. Devised a deadly trap for unfortunate but very annoying mouse.

SATURDAY, Sept. 27. Orville roused from sleep last night by mouse walking across his face. Wilbur suggested covering head, else it might be chewed off as befell one Mona who seemed toothsome to a bear. The impudent mouse, who has eaten corn bread bait, will pay for insulting conduct.

Monday, Oct. 6. Mouse dies a natural death.

Wednesday, Oct. 15. Cold enough for five blankets last night and the shivering inventors had but four! Orville made slingshot to defend camp against intrusive razorbacks.

Friday, Oct. 17. They collected shells and starfishes at the beach for small nephews and nieces, children of their brother Lorin.

While confident of their new lore, the prudent Wrights tested the glider for the first time as a kite. They also wished to know whether it would soar at a small angle and were pleased when it confirmed calculation by floating at an incline of seven degrees.

The next day they began gliding against the wind from the 100-foot eminence of Kill Devil Hill. Wilbur was the rider when a gust hit the left wing, causing it to rise. The prone pilot needed to act in a hurry. He promptly shimmied his hips to warp the wings and moved the front elevator with his hands. But he forgot in his excitement that the control system was different from last year and made the wrong move! The glider reared up like an outlaw mustang, slowed, and threatened to topple backward. Wilbur had a split second or so to correct his error. He reversed the rudder and also lunged forward to bear down with his weight on the high end. Orville below held his breath and then sighed with relief as the glider's nose went down and it planed off to a fair landing.

THERE was real peril of death in these pioneer flights even with motorless craft and small elevations. The brothers knew that Lilienthal, the German, had been killed by a drop of fifty feet and Pilcher, the Englishman, by a fall of forty feet. The Americans needed all their athletic ability. They had kept themselves in physical trim with senses keen and bodies nimble. The Wrights could not have invented the airplane without their personal ascents, which is not the same as saying that aviation came from acrobatics. But we may conclude that the Chanutes, Langleys, Maxims, and others had no chance of success in that they were personally unable to take the air.

While both the Wrights advanced in aerial observation, Orville especially noted significant details in brief (Continued on page 146)

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but thrilling trips through the atmosphere. Orville made a long, careful record in his diary on September twenty-third, telling just how he crashed backward that day from a height of some thirty feet, damaging the glider considerably but not himself. Despite the accident, he and his brother were more than cheerful in view of the machine's good behavior in control and ability to soar at low angles.

The new feature of a vertical tail—which was rigid—had been added as an aid to lateral balance and to prevent a tendency of the machine to pivot or turn on its axis when the wings were warped. Sometimes the tail seemed thus useful and then again quite the reverse. The wing tips were shifted to curve like those of a gull, as in the previous glider. That did not help any. They went back to the tail as the crux of a mysterious problem. Orville had the luck to be sleepless on the night of Thursday, October second, as he lay in his canvas bed amid the ceiling beams of the shed at Kitty Hawk, for he then had the inspiration that the tail should be movable! He recorded the fact in his diary the next day, using just twelve words to state this major discovery.

IT HAD come to him in the night that a movable rudder turned toward the high or fast wing would check its speed, reduce its undue lift, and thereby restore lateral balance. Turning the rudder right or left would keep both wings even and the craft level in the lateral plane. Was this a new idea? It was revolutionary! Mariners had used rudders from the dawn of time but for the purpose of steering ships. But the object of the aerial rudder was totally different, that is, to maintain sidewise equilibrium in conjunction with warpable or movable wings.

As Orville had adopted forthwith the amendment to his hinged wings—warping that Wilbur visualized through a twisted pasteboard box—so now the latter instantly accepted the movable vertical rudder. And, as usual, Wilbur offered an improvement. Since the rudder would have to be turned each time the wings were warped, let rudder and wings be connected with wires so as to operate together. Thus one lever would control lateral balance. Another lever would take care of fore-and-aft equilibrium.

THURSDAY night came the inspiration, Friday its application was discussed, Saturday afternoon the Wrights were making the new rudder. Orville tells the latter fact in his diary record of Oct. 4, along with the statement that foodstuffs were short, which was important to him as housekeeper, since Chanute and Herring arrived the next day.

The improved glider during the next ten days or so made about 700 flights with a success unprecedented. It sailed against a thirty-five-mile-an-hour wind and repeatedly covered distances over 600 feet. It was balanced with ease, guided high and low, right and left. There was no serious attempt to circle nor to attain much altitude. The season's total record of flights was 1,100.

The Wrights did not know it, but the airplane was practically completed! The new rudder had added the hitherto lacking twenty-five percent, which, combined with an equal warping value and fifty per cent of aerodynamics, gave mankind everlasting control of the air.

Wilbur and Orville did not see any great future for their vehicle and were far from dreaming that it would some day crowd the sky. They looked on it as a scientific feat of fair dimensions. A motor would make the glider go faster and farther. Before leaving Kitty Hawk this year they began to design a power machine and (*Continued on page 147*)

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to draw up a patent application. The patent was not in expectation of any money return, but just to establish a record of priority for the sake of scientific credit.

Chanute saw the Wrights' performance with tempered enthusiasm. His own pair of gliders had failed utterly in the hands of his employe, Herring. The Wrights had reason to be surprised, therefore, when the latter told them he would rejoin them at Kitty Hawk next year with a power machine of his own.

"Guess I'll go home to Chicago by way of Washington," casually announced Herring at camp breakfast on Tuesday, October 14.

"Hm, I'll go that way too," said Chanute.

THE engineer and his mechanic left camp that day en route to Washington. Chanute met and talked with Langley, while Herring missed him. Here is a letter that sheds light on the situation:

Smithsonian Institution,
Washington, D. C. Oct. 17, 1902.

Dear Mr. Chanute:

. . . I should like very much to get some description of the extraordinary results which you told me were recently obtained by the Wright brothers. I have today a letter from Mr. Herring, who was in the city, speaking of some ideas which he would like to submit. . . . I have inferred that he might have been with you at these Wright trials, and have those in mind in what he writes. I have not, however, felt able to take him again into the Smithsonian service. . . .

Very truly yours,
S. P. Langley,
Secretary.

Two days later Professor Langley sent the following wire:

Washington, D. C. Oct. 19,1902.

Mr. Wright,
Kitty Hawk, N. C.

Mr. Chanute has interested me in your experiments. Is there time to see them? Kindly write me.

S. P. Langley,
Secretary, Smithsonian Institution.

The brothers replied they had broken camp and ended their experiments.

Professor Langley continued eager to partake of the Wrights' knowledge, as shown by his letter of Dec. 7, the same year, to Octave Chanute:

"I SHOULD be glad to hear more of what the Wright brothers have done, and especially of their means of control, which you think better than the Penaud. [An automatic balance device of no value.] I should be very glad to have either of them visit Washington at my expense, to get some of their ideas on this subject, if they are willing to communicate them. I have been spending a great deal of time and money on an apparatus to accurately measure the lift and drift of the wind. [Which the Wrights had done for all time with their $15 wind tunnel!] It is nearing completion, and I should be glad to have you see it."

These letters explode an old myth that Langley was teacher and the Wrights his pupils. In fact, the relation was reversible. Langley could have been, and wished to be, taught by them, but they politely declined the opportunity.

Next month—the first flights in a power machine. A thrilling, intimate account of the Wrights' epochal triumph which at last gave mankind mastery over the air. You won't want to miss this dramatic story—the greatest ever.

Hunts Earthquakes in a Submarine

(*Continued from page 45*)

floor, tending his pendulums to keep them swinging steadily.

When the submarine reached a particularly deep hole it dove into it for the measurements—much to the uneasiness of the crew, who greatly preferred to dive in shallow water where there would be a better chance to escape if anything went wrong. Thus Dr. Vening-Meinesz explored Sigsbee Deep, a trough in the Gulf of Mexico; Bartlett Deep off the southern coast of Cuba; and, to the north, Nares Deep, a steep-sided oceanic hole of tremendous size.

Dr. Vening-Meinesz measured the pull of gravity in each place, for gravity and earthquakes are believed to have a close connection. If one spot on the earth's crust is heavier than another—as betrayed by its increased gravity pull—it is likely to settle. A light piece of the crust will rise. Most of the crust, geologists think, is balanced, having long ago adjusted itself. But a few sections haven't, and these are believed to cause most, if not all, of the earthquakes when they finally yield.

SO THE Dutch expert sought inequalities in the crust's weight at different places undersea. Hitherto, such studies could be made only on land, a small part of the earth's surface. But a curious happening led Dr. Vening-Meinesz to design an apparatus that would serve also at sea.

He was attempting to measure the force of gravity near Holland's coast with the imposing-looking pendulum device formerly used for such measurements—and unfit for use at sea because, when the boat rocked, the pendulum wouldn't work. He couldn't get a satisfactory reading! Even on land the pendulum swings were irregular and unsatisfactory.

At first the experimenter thought motor traffic on near-by highways shook his machine. But at last he decided that waves breaking on the shore upset the balance of the sensitive instrument—and that their effect permeated the entire soil of western Holland.

To offset this obstacle, Dr. Vening-Meinesz began designing an instrument immune to vibration. He finally perfected a double pendulum that avoided the trouble. And he found that it was even better than he hoped—good enough, in fact, to be used at sea.

SUCH was the inspiration of a series of submarine cruises in many parts of the world, of which he recently completed the latest. One of its principal aims was to find if the Mississippi's delta, augmented yearly by a cubic mile of river silt, was dangerously weighting the undersea crust, as geologists feared. He found that it was not. Other measurements revealed which regions of the Gulf of Mexico and Caribbean were likely to produce earthquakes.

Of particular interest to geologists was the fact that this cruise, like those before it, verified the theory of "isostasy" evolved from land measurements over seventy years. According to this theory continents float above sea level because they are lighter than undersea areas. In other words, despite inequalities of mountains and holes in the sea, a boring anywhere on the earth weighs the same as any other boring of like size. This is true everywhere, geologists believe, except in the few unbalanced areas that produce quakes.

If this is so, as Capt. C. S. Freeman, Superintendent of the Naval Observatory, points out, it has important consequences. It gives an accurate yardstick to measure distances to the sun and stars, based on exact knowledge of the earth's size. It offers a possible means of predicting earthquakes with some assurance. It also suggests a way of tracing valuable undersea mineral deposits by gravity measurements.

Super-Power for Your Radio

(Continued from page 65)

designed to be operated, the hum is not noticeable, even when the input signal strength is kept so low that the output volume is at quite moderate volume.

In the picture wiring diagram of Fig. 3, note that a number of wires terminate in small stars. These stars indicate metallic contact with the sheet metal covering the base. In the theoretical diagram of Fig. 2, the sheet metal base is represented by the heavy black minus-B and ground line.

It is not necessary to see that the metal frames of the transformers and the cases of the condensers are grounded. Clamping them to the metal covered base automatically takes care of this.

The arrangement of the sockets, resistances, and so on is clearly shown in Figs. 1 and 3.

CAUTION! Be extremely careful in putting in the high-voltage wiring, particularly where it passes through a hole in the sheet metal. All such wires should be covered with a short piece of spaghetti tubing in addition to the regular insulation. This includes the wires from the *H* terminals of transformer *A1*, all the wiring connected with the sockets marked for 281 rectifier tubes, choke unit *B*, the speaker field binding posts, the *B* terminal of transformer *A6*, and resistance *R1*. Other wiring passing through the sheet metal needs no special additional insulation. It is important, however, to guard against scraping insulation from the wire when pulling it through the holes. Make the holes large enough and you will have no trouble. Make sure, too, that you do not short-circuit the socket terminals when you solder the wires to them. The solder lugs are close to the sheet metal and a drop of solder hanging from the lug may cause a short circuit. As a safeguard, slip a piece of cardboard under each socket terminal while soldering a connection. Then if the cardboard slips out easily after the job is done, you will know that there is no short circuit.

WARNING! DO NOT TOUCH ANY PART OF THE AMPLIFIER WHILE CURRENT IS TURNED ON!

THE operation of the amplifier is simple. The leads from the field of the dynamic speaker are connected to the end binding posts, and resistance *R1* should be set to the greatest amount of resistance consistent with keeping the 874 voltage rectifier tube glowing steadily. The function of this tube in the circuit is to steady the voltage and at the same time increase the load so that sufficient current will flow through the speaker field when external *B* requirements are light. Do not operate the amplifier unless all tubes are in the sockets.

R3 should be set so that the B-voltage on the 226 tubes is 135. Use a set analyzer or high resistance voltmeter for the purpose. If you have no way of ascertaining the voltage, set the resistance contact at the halfway point.

The same method should be used in setting *R4*. The ninety-volt terminal supplies ninety volts regardless of the external load because of the automatic regulation of the voltage regulator tube, type 874.

This unit will supply field current for not more than two dynamic speakers. The transformer in the base of the speaker should be disconnected and the voice or moving coil connected directly to the binding posts marked. In the case of two dynamic speakers, connect the voice coils in parallel.

If magnetic cone-type speakers are to be used, short-circuit the field binding posts and connect the cone speakers to the *P* terminals of transformer *A6* by way of two condensers, as shown in dotted line in Fig. 2, the condensers being marked *X* and *Y*. Use four-mfd., 600-volt condensers.

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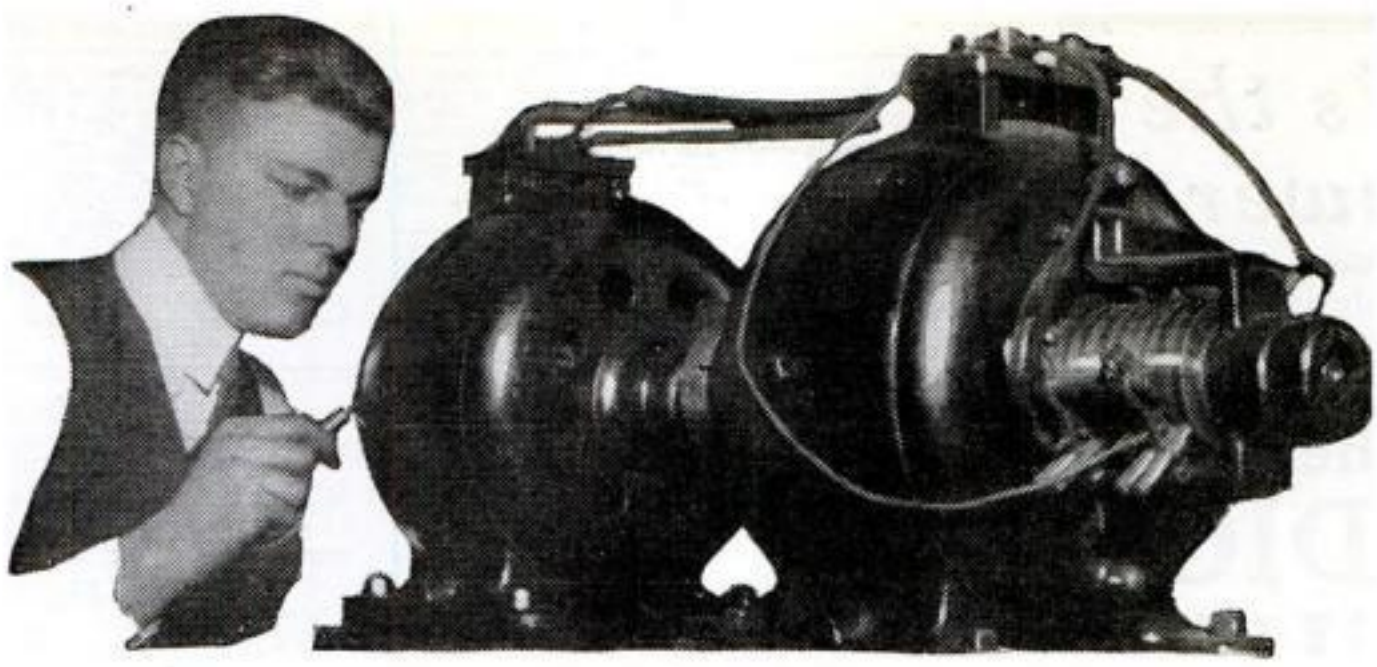

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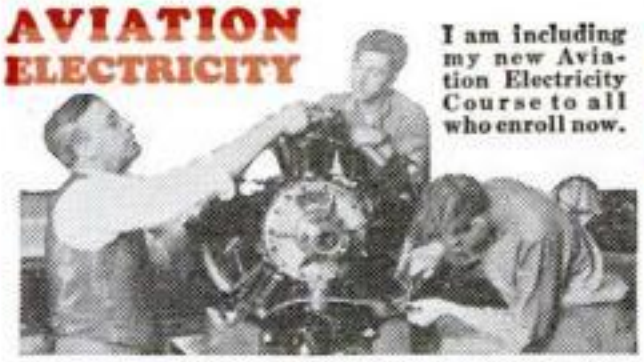

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INVENTIONS WANTED—Patented, unpatented. If you have an idea for sale write Hartley, Box 928, Bangor, Maine.

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YOUR chemical problem solved and working formula or process furnished for $5.00. Write me. W. Stedman Richards, Industrial Chemist, Box 2402, Boston, Mass.

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PATENTS procured at reasonable rates with time to pay. Sales negotiated. Staff of registered attorneys and engineers. Write for particulars. Inventors Service Bureau, Dept. A48, Washington, D.C.

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MAKE money in Photography. Learn quickly at home. Spare or full time. New Plan. Nothing like it. Experience unnecessary. American School of Photography, Dept. 1743, 3601 Michigan Avenue, Chicago.

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This invention is based on newly-discovered facts about potential gasoline power that few car owners know about. For example, it is now found that the average man wastes at least 20% to 30% of his gasoline through improper combustion. And many more interesting discoveries, too detailed to mention here.

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Don't send a penny now. Simply send your name in coupon below. J. A. Stransky Mfg. Co., C-730 Stransky Block, Pukwana, S. D.

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Herrick made $157 in a day, letting Stransky vaporizers sell themselves. Territories open everywhere. Full or spare time. Check coupon below.

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Yes, send me full description of this new way to save gasoline. This request does not obligate me in any way.

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JUST Out—New Patented Apron. No strings or straps—$20.00 a day every day; over 100% profit; commissions daily. Write for free offer. Sta-Put Co., Dept. 903, St. Louis, Mo.

$100 WEEKLY Easily earned selling new patented electric water heater. It sells for $6.50 and you pay us $3.00. Write to Jiffy Electric Water Heater Co., 842 Maxlow, Royal Oak, Mich.

PUNCHBOARD Men! Sideline Salesmen! Sensational Merchandise Catalog just added to famous "Lincoln Line"! No more closed territory! $200 Weekly Easy. Repeat Commissions Paid Daily. Smashing. Color Catalog Free. Samples unnecessary. Best Season Now! Get Busy! Lincoln Sales, 9 So. Clinton, Chicago, Dept. G.

GET our Free Sample Case—Toilet Articles, Flavorings and Specialties. Wonderfully profitable. LaDerma Co., Dept. F, St. Louis, Mo.

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$3.90 PER HOUR Selling a service to keep stairways clean. Every housewife interested. Write today. Ideal Stairway Equipment Co., Dept. PS, Canton, Ohio.

AMERICA'S Greatest Tailoring Line Free. 175 Large Samples—All Wool—Tailored to Order—Union Made—Sensational Low Price. Big Commissions paid daily. Cash bonus besides. Exclusive territory to producers. Hustlers making $100 a week and up. Get outfit at once. Address Dept. 55 Goodwear, 844 Adams, Chicago.

I PAY my agents $90 a week just to wear and show my beautiful new Free raincoat and give away Free hats. Write today for yours. Robert King, 230 So. Wells, Dept. AC-3, Chicago.

STRANGE Invention! Pays $25 Daily. Keeps telephone and iron cords from tangling and kinking. Prevents iron scorching. Saves electricity. Samples free. Neverknot, Dept. 3-F, 4503 Ravenswood, Chicago.

A NEW Deal by an old house for men seeking big opportunity and pay. Union made-to-measure all-wool suits at $23.50 up. Double ordinary size samples. Big commissions and bonus. Write for details or give experience and references for return action. Pioneer Tailoring Co., Congress and Throop, Dept. C-1121, Chicago.

AGENTS Make $3.00 an Hour Taking Orders for our 40 fascinating Kitchen Specialties. No competition. Write quick. General Products Co., Dept. C-231, Newark, N. J.

SELL Ties—Make Big Profits—Get Big Sample Selling Outfit absolutely FREE. Wonderful patterns—Splendid Values—Liberal Commissions. Write TODAY to Public Mills, 4927CG Hudson Boulevard, North Bergen, N. J.

AGENTS: Buy for one cent a package fifty-cent size; extracts, pie-fillings, toilet articles. "Holland," Harvey, Ill.

AGENTS wanted to advertise our goods and distribute free samples to consumers; 90c an hour; write for full particulars. American Products Co., 2521 Monmouth, Cincinnati, Ohio.

FREE—1000 Money-Making Opportunities from reliable firms. Sample copy free. Specialty Salesman Magazine, 4015 Mather Tower, Chicago.

SELL Durable Rubber Namats—$6.00 An Hour Easy—All Business Places Buy. Men! Sell these Durable Rubber Namats either as a side line or full time. Store dealers, banks, apartments, hotels and all buy on sight. Show samples and pictures and how their name will look and get the order and pocket your liberal cash commission. Attractively made and has great advertising value for the user. Show them our line and make an easy $6.00 an hour. Write for outfit and start taking orders at once. Durable Rubber Co., Dept. F, 1140 Broadway, N. Y.

$15 DAILY paid men, women to show finest neckwear. Biggest values. Experience unnecessary. Free samples sent first 500 applicants. Nawco, Desk YC-110, Covington, Ky.

$100 WEEKLY—appointing agents Mother Hubbard Foods. No canvassing, delivering or investment. Mother Hubbard Products, 554V Congress, Chicago.

AGENTS cleaning up with Lanowa Combination. 65c clear profit every dollar sale: Write for free sample. Great Western Industries, 4125H Penn, Kansas City, Mo.

"HAVE wonderful proposition on new hand soap—tools and supplies. Need man with car to make deliveries. Can earn $2.00 an hour. Work is near home. No experience required. Write for free sample and full particulars. The Connecticut Can Co., Hartford, Conn."

$15.00–$25.00 DAILY easy representing manufacturer INSTANT WELD, Marvelous New Rubber Repair. Dealers—Individuals everywhere buy on sight. Write for free sample. Tourists Pride Manufacturing Co., Desk F, Minneapolis, Minn.

BRAND NEW—Clever 8-in-1 Household device mops, cleans walls, and ceilings. Housewives wild over it. Popular price, Big commission. Make $15 daily. Kleanezy Co., Dept. L-29 Delphos, O.

A PAYING position open to representative of character. Take orders shoes-hosiery direct to wearer. Good income. Permanent. Write now for free book "Getting Ahead." Tanners Shoe Mfg. Co., 2012A C St., Boston, Mass.

BIG Pay Every Day taking orders for Dress and Work Shirts, Pants, Overalls, Sweaters, Underwear, Hosiery, Pajamas, Playsuits! Experience unnecessary. Outfit FREE! Nimrod Co., Dept. 25, 4922-28 Lincoln Ave., Chicago.

SCREW-HOLDING screw driver! Amazing brand new patented invention! Retails $1.50. Factories, garages, electricians, auto, radio owners buy on sight! Exclusive state territory. Genuine opportunity earn big money. Free Trial offer. Jiffy 1055 Winthrop Building, Boston.

Salesmen and Agents Wanted

MAKE $500. Show tablecloths. Save laundry bills. Women scramble for them. Free sample. Mohler, Box 453-Y, Chicago.

$8 DAILY extra; free equipment; free sample caps, hats. Amazing new money-making opportunity. Write quick for outfit. Fits-U caps, Dept. EC-80, Cincinnati, O.

GOLD Leaf Window Letters and Script Signs; no experience; 500% profit; Samples free. Dearman made $19.20 first 2 hours. Consolidated, 69-Y, West Van Buren, Chicago.

$100 WEEKLY! Amazing new auto invention! Big sensation. Accurately registers oil and grease changes. Low Cost. Free Offer! Lu-Barometer Co., B-229 S. Market, Chicago.

MEN wanted to canvass Farmers. $160 Monthly and expenses. Opportunity for advancement. Bigler Co., M-18, Springfield, Ill.

$2.95 AUTOSEAT Covers—Cash Daily—Amazing All America—Postcard brings Leatherette Sales Outfit. "Quality," P513 So. Dearborn, Chicago.

Sales Promotion

COMPLETE analysis of your sales problems. Formally with Crosley Radio. George Banning, Times Building, Watertown, N. Y.

Song Writers

SONG Writers: Let's see what you have to offer! Escher, Music Publisher, 1547 Broadway, New York City.

SONG, poem or melody writers. Have "real" proposition. Hibbeler, D10, 2104 N. Keystone, Chicago.

SONG Poem Writers. Address, Monarch, 236 W. 55th, Dept. 226 New York.

ALL Advertisers should no: be without the important facts on Money Making. Write today for the "Quick-Action Advertising Rate Folder" which contains information of value to you. If you are anxious for quick profit returns, do it now! Address your inquiry to: Manager, Classified Advertising, Popular Science Monthly, 242 Fourth Ave., New York

SONGWRITERS: Submit Your Song Poem or Complete Song! Will return it immediately if not accepted! Chester Escher, Music Publisher, 125 W. 45th St., New York City.

Stamps and Coins

STAMPS, 100. All different, 3 cents. Lists free. P. S. Quaker Stamp Co., Toledo, Ohio.

20 VARIETIES unused free. Postage 2c. P. S. Miami Stamp Co., Toledo, O.

STAMPS, 105 China, etc., 2c. Album (500 illustrations) 3c. Bullard, Station BB, Boston.

RARE United States and foreign coins, war medals and decorations. German bill and catalogue, 10c. Alexis Mengelle, Colorado Springs, Colorado.

CALIFORNIA gold, quarter size; 27c, $½ size; 53c. White cent and Catalogue, 10c. Norman Shultz, Salt Lake, Utah.

OLD Coins, large Fall selling catalog of coins for sale free to collectors only. Catalog quoting prices paid for coins, ten cents. William Hesslein, 101B Tremont St., Boston, Mass.

600 DIFFERENT $.50, 1100, $1.00, 2000, $3.50. Fred Onken, 630—79th Street, Brooklyn.

300—300—300. ALL different stamps (cat. over $6.00); 300 hinges; 5 approval sheets; duplicate stamp album; perforation gauge; millimeter scale and ruler to approval applicants only for 20c. Edgewood Stamp Co., Dept. S, Milford, Conn.

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Stories Wanted

BIG demand for Photoplay and Magazine Stories. We revise, develop and copyright. Sell on commission. Established 1917. Booklet free. Universal Scenario Company, 414 Western & Santa Monica Building, Hollywood, California.

Telegraphy

TELEGRAPHY—Both Morse and Wireless—taught thoroughly, quickly. Big salaries. Wonderful opportunities. Expenses low; chance to earn part. School established fifty years. Catalog free. Dodge's Institute, Hart Ave., Valparaiso, Ind.

Typewriters and Supplies

TYPEWRITERS—Factory Rebuilt Royals, Remingtons, Underwoods. New Royal, Remington and Corona Portables. New "Excellograph" Rotary Stencil Duplicator $37.50. Terms. Catalogue Free. Pittsburgh Typewriter Supply, 543—339 Fifth Ave., Pittsburgh, Pa.

Wanted

WANTED—Live foreman or mechanic or clerk in every factory in the United States to act as subscription representative for the most popular magazine in the world. Address Manager of Representatives, Popular Science Monthly, 250 Fourth Ave., New York.

WANTED—District Purchasing Agents. No experience or money required. Write Purchasing Manager, 5336 Berenice Ave., Chicago.

USED courses—Standard Correspondence Schools. Sold, rented. Guaranteed. Courses bought. Aneslys, 2353 Main, Buffalo.

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"I Found the Short Cut to Success in Radio

through this amazing home laboratory method!"

The only radio training sponsored by RCA . . . General Electric, Westinghouse . . . FREE 50-page book tells all about it. Mail coupon.

By *Frank Halloran*

I GOT hungry to get into Radio when I learned about the big money it was bringing my next door neighbor.

He was only twenty-eight years old, but his income was over four times as much as I was getting. He owned a fine car, dressed in expensive clothes, took week-ends off to go hunting and fishing, and was one of the most popular fellows in town.

"Charlie," I asked him one day, "how did you become a radio expert?"

"A cinch," he smiled. "I took it up in my spare time at home."

"What?" I asked in surprise, "you actually took a radio course by mail?"

"No," he shot back. "Not just a mail order course, but the only technical home-laboratory training conducted under the auspices of RCA, Westinghouse and General Electric! Believe me, these 'big-league' organizations not only know what's what in radio, but they know how to teach it!"

A Great Piece of Luck

Taking Charlie's advice was the luckiest thing I've ever done. It's bringing me more money in a week than I've often earned in a month!

I never dreamed that learning radio at home was so easy and so fascinating. From the very first lesson to the last I was thrilled! Each subject was explained in simple word and picture form . . . . and written in such an interesting style that I was carried along like a novel!

I didn't know the first thing about radio when I started, yet before many months were over I was able to solve many of the problems which now help me command big money. The lessons took me step by step through trouble-finding and repairing . . . . through ship and shore and broadcasting apparatus operation and construction . . . . through photoradiograms, television and beam transmission . . . . through radio salesmanship, store operation and executive work.

Success—In Spare Time!

I didn't have to give up my regular job. I learned at home during my spare time. And I actually learned by doing! With the course, I received an outlay of the finest standard apparatus with which I was able to build radio circuits and sets of almost every description . . . . yet this expensive apparatus cost me absolutely nothing extra!

Even before I had completed the course I was able to earn good money doing odd radio jobs. And it wasn't long after that I was able to give up my regular work and branch out for myself as a full-fledged expert in work that is fun and extremely profitable!

Today, my income is more than doubled . . . . and I've only just started! I'm certainly happy that I found this short cut to success!"

Read This Thrilling FREE Book

Frank Halloran's wonderful success is just another typical example of the success which the Radio Institute is bringing to hundreds of men everywhere through its wonderful Home-laboratory training . . . the only official radio training based on the inside knowledge of radio developed in the great experimental laboratories of RCA, General Electric and Westinghouse!

There is an amazing opportunity for you in Radio. Manufacturers, dealers, broadcasting stations, ships . . . all are calling for trained radio experts. The pay is big—the opportunities are limitless—the work is thrilling! Find out all about it. The Institute has prepared an interesting, illustrated booklet telling you all you want to know about this vast industry and about the remarkable home study-course that can fit you for a brilliant radio career. Just mail the coupon below and claim your copy of this valuable booklet . . . *it's absolutely free!* Radio Institute of America, Dept. PS-3, 326 Broadway, New York

Mail this coupon

Radio Institute of America
Dept. PS-3, 326 Broadway, New York, N.Y.

Gentlemen: Please send me your FREE 50-page book which tells all about the great opportunities in Radio and about your famous home-laboratory method of guaranteed radio instruction sponsored by RCA, General Electric and Westinghouse.

Name.....

Address.....

Why a "Cheap" House Costs Most

(*Continued from page 75*)

amount for financing, is divided among the architect, the builder, and the landscaper.

Examining the simplified budget above reveals some startling truths. No longer does an item of $435 for hardware, in a $15,000 home, seem so excessive that we are tempted to substitute cheaper hardware. The item represents only about three cents of the whole building dollar. We could substitute brass-plated steel hardware for brass, but the plated stuff would wear and rust. So, too, we notice that $165, which seemed excessive for rust-proof flashing, downspouts and gutters, represents but one cent of the whole building dollar. Surely there must be better ways to economize, should the total cost of the home prove too much, than by skimping on these. There are—and they can be done without sacrificing the essentials.

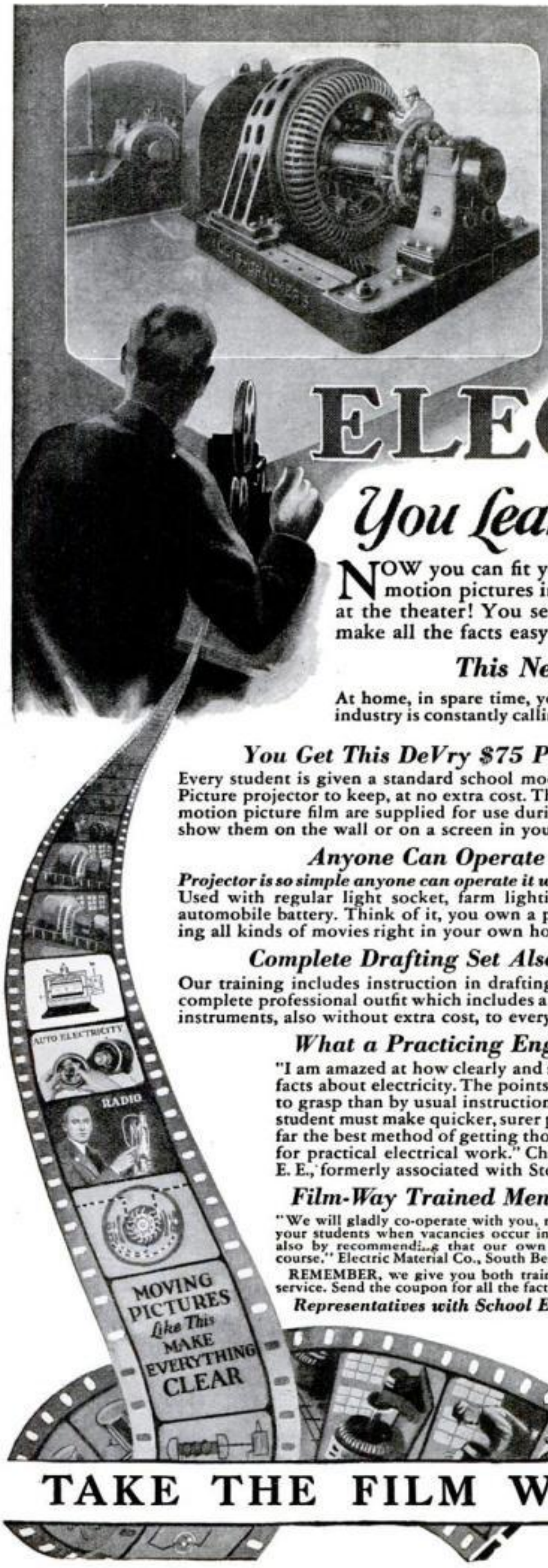
LET us examine the budget once again. Here is the biggest single item—the carpentry bill for labor and materials. It would be foolish to substitute undersized floor beams in the vital frame of the house—but there is a breakfast nook, in the plans, that can wait until we can better afford it, as well as a window seat and built-in bookcases. If worst comes to worst, we can forego oak floors and use a cheaper material that, well-chosen, will give satisfactory service.

We hesitate to economize on plumbing. Brass piping is expensive, but trouble-proof. The heating system, a single-pipe steam system, is about the most inexpensive of its kind, though in some houses a one-pipe warm air furnace might serve the purpose. We cannot skimp on painting and be sure that a good quality paint will be used. Nor can we economize on the cost of electric wiring, which must be done under the rules of the insurance underwriters.

But that tiled bathroom is an expensive item, and we can get along comfortably with a wood floor and cement walls for the present. Tiles can be put in later. A sun room is another big expense, and only the foundation for it need be built just now.

IF MORE drasticeconomies are still needed, we can alter our plans somewhat and cut the size of the rooms at a considerable saving.

The result? We have a home that, however modest, is sound throughout. Life in it will be a comfort and a pleasure for many years to come. By spending judiciously within the bounds of our ability, we have made it sturdy, and permanent.



Big Pay Jobs *for You in* ELECTRICITY

You Learn by Seeing it Work

NOW you can fit yourself for a big pay job in electricity by watching real motion pictures in your own home! Easy and fascinating as seeing a show at the theater! You see electrical machinery ***in operation.*** Moving diagrams make all the facts easy to understand.

This New Way is Easier, Quicker, Surer

At home, in spare time, you can fit yourself to make more money in electricity. This giant industry is constantly calling for men to fill jobs paying from $70 to $200 and more weekly! Practical electrical men, holding down big jobs, praise this new way, which is called Film-Way Training, ***as the easiest and best way to learn how to do electrical work.***

You Get This DeVry $75 Projector

Every student is given a standard school model DeVry Motion Picture projector to keep, at no extra cost. Thousands of feet of motion picture film are supplied for use during the course. You show them on the wall or on a screen in your home.

Anyone Can Operate It

Projector is so simple anyone can operate it without experience. Used with regular light socket, farm lighting equipment, or automobile battery. Think of it, you own a projector for showing all kinds of movies right in your own home!

Complete Drafting Set Also Given

Our training includes instruction in drafting, and we supply a complete professional outfit which includes a fine set of drawing instruments, also without extra cost, to every student.

What a Practicing Engineer Says:

"I am amazed at how clearly and simply you explain facts about electricity. The points are so much easier to grasp than by usual instruction methods that the student must make quicker, surer progress. This is by far the best method of getting thorough preparation for practical electrical work." Charles E. Fitz, M. E., E. E., formerly associated with Steinmetz.

Film-Way Trained Men in Demand

"We will gladly co-operate with you, not only in employing your students when vacancies occur in our organization and also by recommending that our own employees take your course." Electric Material Co., South Bend, Ind.

REMEMBER, we give you both training and employment service. Send the coupon for all the facts now.

Representatives with School Experience Write

You Get This Pledge in Writing

We promise in writing to give you the training and employment service necessary to get you a better job and more money, ***or you need not pay a cent.*** You take no chance; you cannot lose. Start now to get a better job and a raise in pay.

FREE Our Big New Book, *"The Film-Way to Bigger Pay"*

Tells all about how we use moving pictures to train you for bigger pay. Also explains our employment service which actually helps you get the job you want. Get your copy now. No obligation to you, of course. Send the coupon TODAY!

Mail This Coupon

The NATIONAL SCHOOL of VISUAL EDUCATION

"The Film Way to Bigger Pay"

537 S. Dearborn Street, Chicago, U.S.A. Dept. 3-F

Send your book, "THE FILM WAY TO BIGGER PAY," with full facts about this new, easier way to master electricity.

Name..... Age.....

St. or R.F.D.....

City.....

State.....

TAKE THE FILM WAY TO *Bigger Pay*

How They Sank and Saved the *S-4*

(*Continued from page 21*)

sinking of a year before, however, there were no human beings aboard her this time. She went under bow first at an angle of about ten degrees.

"I did this on purpose," Commander Dunbar told me; "we let six tons of extra water into her forward trim tanks. At first, we planned to sink her on an even keel, but I decided later to approximate actual wrecking conditions as closely as possible."

The bottom was mud, and the *S-4* stuck her sharp nose into it just as she had done in her fatal dive a year before. Marker buoys shot to the surface, along with the descending line fixed to the yellow buoy for the benefit of the divers. This was immediately fished aboard the *Falcon*. The descending line is a stout rope which guides the diver in his descent.

Now the submarine was sixty feet below the surface. As soon as she had slid down, all was bustle aboard the *Falcon*. The salvage vessel maneuvered herself to a position directly above the *S-4*. Divers were being buckled into their clumsy, canvas, rubber-lined suits. Before his big bronze helmet was put on, one of them shouted:

"IF I stay down among the herrings, break the news gently to the folks, will you, boys?"

When they were dressed for the job, looking like grotesque, part-human creatures equipped to inhabit two elements instead of one, Chief Torpedoman Edward Kalonoski was the first to reach the descending rope. He hooked one of his legs around it, and dropped like a dart to the bottom. It took him just half a minute to reach the ocean floor!

Kalonoski was followed quickly by Torpedoman Edward Yeadon. In what seemed but a moment, the words, "Ready, sir," came from the telephone inside Kalonoski's helmet. A similar report arrived over Yeadon's wire. Two seamen standing by lowered a stout rope to them. This they passed through the first pad-eye, and the loose end was brought back to the surface. It was tied to a steel cable and, by means of a winch, the cable was drawn through the eye. To the end of the cable, sailors attached an anchor chain. When its first link reached the pad-eye, a third diver went overside to shackle it fast. By that time, darkness had fallen, and operations were stopped for the day.

THE next morning a forty-mile northwest gale chopped the waters of the bay into white froth. During the night, the temperature had dropped from forty-four to below freezing. Protected by extra suits of woolen underwear and socks under their huge suits, the divers continued to make descents all through the day, and by dusk the three other anchor chains had been shackled fast.

Then the pontoons were sunk. Three of them were used in the experiment. They are really huge steel barrels sheathed with wooden strips. Each has three compartments, and one compartment can be flooded at a time. The idea of this is to be able to sink them on an even keel in a rough sea.

From the *Falcon*, water was let into both end compartments of each of the giant barrels; the middle compartments were left empty for the sake of balance. After they were flooded, the pontoons went straight down over the sunken submarine. Divers again went overside to fasten the barrels to the submersible with anchor chains.

When divers reported everything O. K., the *Falcon* signaled to the *Chewink* that the attempt to raise the *S-4* would be made at 7:30 o'clock that evening. A group of anxious officers in sheepskin (*Continued on page 160*)

He Mailed a Coupon Like This

Rhodes Manufacturing Co., Dept. C-243
1418 Pendleton Ave., St. Louis, Mo.

Without obligating me, please send me illustrated description of KRISS-KROSS Stropper and your offer of a 3-Way Razor FREE.

Name.....

Address.....

City.....State.....

( ) Check here if interested in becoming representative.

...and it Brought Him 1129 Cool Shaves from One Single Blade!

Another Triumph for KRISS-KROSS! The Most Amazing Shaving Invention Ever Patented! Mr. T. Liddle, of Illinois, Wrote Recently: "I have Been Using One of Your Stroppers Since May, 1924. I Shave Every Morning and I am STILL ON MY FIRST BLADE!" Read Astonishing Details. Then Act at Once for Real Shaving Joy.

NO wonder KRISS-KROSS marks such a radical advance in shaving comfort and economy! For now at last it has captured a secret that has baffled scientists for years! It actually reproduces mechanically the diagonal flip-flop master-barber's stroke that gives razor blades the keenest cutting edge that steel can take! Pressure decreases automatically. And in just 11 seconds you are ready for the coolest, slickest shave you ever had!

An Economy—And a Luxury, Too

KRISS-KROSS not only introduces you to undreamed-of shaving luxury—but cuts shaving costs 83%. It makes your blades last almost indefinitely. Any number of cases are on record where a KRISS-KROSS user reports over 365 keen shaves a year from the same blade! For example, C. S. Stephenson (Oklahoma) writes: "I have been using one blade continuously for one year and nine months and have no idea how much longer it will last."—No wonder there are over a million satisfied users of KRISS-KROSS in America today!

Sharpens Any Make of Razor Blade

KRISS-KROSS works on practically any known make of razor blade, single or double edge (except Durham). Gives excellent results with Gillette, Gem, Valet Auto-Strop, Keen-Kutter, Enders, Ever-Ready, Darwin, Schick, Christy and over 2 dozen others.

Get Free Offer

And now—to introduce this sensational device that makes old blades keener than new—we are giving with it *free* an amazing new kind of razor. Instantly adjustable to any angle. Comes with 5 new-process blades. Find out all about this astonishing introductory offer. No obligation. Just fill out and mail the coupon above today!

RHODES MFG. CO., Dept. C-243

1418 Pendleton Avenue ST. LOUIS, MISSOURI

World's Largest Manufacturers of Mechanical Strappers

Canadian Address:
CANADIAN KRISS-KROSS CO., 39 Wellington Street East, Toronto 2, Canada

AGENTS, $5-$15 AN HOUR!

Make big money with KRISS-KROSS! It is sold only through authorized agents who are making up to $200 a week and, in some cases, even more! All you do is demonstrate and take orders for this unique invention which is heavily advertised but never sold in stores. Nine out of ten men want to own it as soon as they see how it works. R. S. Hopkins (Michigan) made $50 his first day. Spare time workers, factory men, mechanics, etc., often make $6—$12 extra a day just showing KRISS-KROSS to friends and fellow-employes. Generous commissions and bonus. No obligation. Get details and liberal proposition today. Check bottom line of coupon **above** and mail it now!

DO IT NOW

How They Sank and Saved the *S-4*

(Continued from page 158)

coats and wool mittens stood on the bridge while blue electric flood-lights played on the tossing red buoys that marked the spot where the submarine lay on the bottom.

In addition to her ballast tanks, the engine room of the *S-4* had been flooded. The officers took turns at giving orders to the sailor at the valves on the bridge. As he turned them, air rushed through the stout hoses leading from the *Falcon's* compressors to the *S-4*. There were showers of bubbles on the water's surface as the air sought to escape from the bottom of the sea.

BUT nothing happened; the old *S-4* insisted on remaining a submarine. Originally, it had been planned to blow just enough water from the pontoons to give them a lifting power of nine tons each. Faced with the inexplicable tantrums of an undersea boat, the officers in desperation now ordered the big steel barrels blown dry to the last ounce. As the air hissed through the twisting hose like escaping steam, the submarine did the entirely unexpected. She came up bow first and then stuck!

I was just lighting a cigarette behind the canvas spray shield on the *Falcon's* bridge when I heard a chorus of excited shouts. Looking quickly, I saw the gray nose of the *S-4* bob into the glare of the floodlights. Higher it mounted and higher, as the air compressors throbbed, until her stem was on a level with the bridge of the *Falcon*—at least thirty feet out of the water! And then nothing could move her.

An officer's conference followed. It lasted until after midnight, when Commander Dunbar announced, "Well, this is all we can do now."

At daybreak the next morning, it was decided that Lieutenant Ives, Lieutenant Momsen, and Chief Gunner C. L. Tibbals, diving expert from the Washington Navy Yard, would go on board the *S-4* to locate the trouble. They did. Commander Dunbar, a small, dark-haired, energetic chap, accompanied them. Tibbals remained on the deck of the sub, while the others, protected by gas masks, crawled down into the submarine through the torpedo loading hatch.

Tibbals yelled to the bridge of the *Falcon* a series of signals he had arranged in case of trouble. They were to be given by hammer strokes inside the hull of the *S-4*, dots and dashes to be sounded on the Flettner oscillator, the underwater telegraph, which honks like the horns of a thousand automobiles.

SOON after the three officers had disappeared into the submarine, the oscillator barked its weird, wolfish cry from under the sea. There was a rush to the rail of the *Falcon* and a chorus of shouts to Tibbals.

"Just testing, I think," he called back calmly. A few minutes later the head of Commander Dunbar appeared. The trouble was that there was a leak somewhere in the hull of the *S-4* and more than forty hours under water had filled the motor room, just back of the flooded engine room. There was no way to blow the motor room dry from the outside, so Lieutenant Ives used the submarine's own "air banks" to drive the unwelcome water back into the ocean.

Back of the pontoons, which were just visible, there was a spontaneous cataract of air bubbles. Then, in the cold light of a winter morning's sun, the conning tower crashed through the whitecaps, and the glistening wet hull of the *S-4* rode the surface of the sea!

Lifting rings on submarines had been vindicated for salvage work. Commander Dunbar said as much. Thus ended the first of the tests which may mean life to many who go down into the sea in submarines.

When the Radio Lion Roars

(Continued from page 47)

men I talked to were writing sketches for a date six weeks in advance. Yet, in spite of every precaution, the unexpected sometimes happens. For example, during the Presidential campaign, a national figure was scheduled to speak for an hour. Because of a cold, he spoke only thirty minutes and stopped. There was a nation-wide hookup, "left flat" without scheduled programs for the next thirty minutes. What happened?

In every large broadcasting studio are accompanists and soloists ready to go on the air in such an emergency. In the National Broadcasting Building, the home of WEAF and WJZ, in New York City, there are not only an octette of singers, each a soloist, but a thirty-five-piece orchestra as well, always ready to fill any "hole in the air." Besides, practically every announcer is a singer and instrumental musician and many have other specialties for an emergency. In the case mentioned above, one of the announcers went on the air in an impromptu song recital.

HOW do the men who make up the programs, go about their work? I asked that question of James Whipple, who originated many of the features you have heard over the Red and the Blue networks. In arranging each program there are three steps, he explained. First, the music is chosen. Next, the continuity writers build the dialogue, writing out every word which will be spoken before the microphone. Then the production department casts the actors, rehearses the piece, times it, and puts it on the air.

An important part of an orchestra rehearsal is placing the instruments properly with reference to the microphone. A player's position may be altered half a dozen times before the director, who listens to a radio reproduction of the music, is satisfied. When the correct position is found, it is noted so the player will sit in the same place during the broadcasting.

In the search for new talent for radio programs, between 100 and 125 auditions, or tryouts before the microphone, are given every week by big stations. Is there any way, I wanted to know, by which a person can discover whether he has a good broadcasting voice without taking an audition? For an answer, I was told a story about the famous novelist, E. Phillips Oppenheim.

A few days after he had given a talk over the radio, he was awakened early in the morning by the telephone.

"HELLO," he said sleepily.

"Is this Mr. Oppenheim?"

"Yes, who is this?"

"Oh, nobody you know. I just wanted to find out if your voice sounds the same over the telephone as it does over the radio."

Most voices, I learned, can be tested for the radio in this way. If your voice has broadcasting possibilities, it will carry well over a telephone. In fact, one casting official makes it a habit to talk to all applicants over the phone before making an appointment. In this way he weeds out the unfit without wasting time. It was over the telephone that Virginia Rae, now well known, is said to have entered radio work. From her home in Louisville, Ky., she called a casting official in Chicago asking for an appointment to try out for a vacancy. He told her the place had to be filled immediately, and there was no time for her to make the trip to Chicago. She suggested that he listen to her sing over the long-distance telephone. He did, recognized the ability of her voice for radio work, and hired her. For bass singers and deep voices, however, the telephone is not a reliable test. It often fails to register low tones which the more sensitive microphone catches perfectly. Every (Continued on page 168)

When the Radio Lion Roars

(*Continued from page 161*)

radio performer has studied how to make his voice "get across," and many have developed original ideas for aiding their performances. For instance Frank Munn, who sings in National programs, holds his hand over one ear while singing. He says it helps him judge the resonance of his voice. Jessica Dragonette, a popular soprano, developed what became known as "the Dragonette weave." She swayed back and forth before the microphone, weaving away on the loud tones and leaning forward to whisper the soft ones. The Scotch comedian, Sir Harry Lauder, tied a wet towel over the microphone before singing into it! Skeptical officials of an English broadcasting station discovered that the canny Scot knew what he was doing. The towel had the effect of emphasizing the singer's voice and subduing the sound of the orchestra.

Speakers who change key suddenly, alternately bellowing and whispering, are difficult to broadcast. Because of the evenness of his delivery, President Coolidge is described by radio men as "good material." John D. Rockefeller, Jr., is another whose voice broadcasts well and who is perfectly calm before the microphone. Gene Tunney, retired world champion heavyweight boxer, on the other hand, usually is nervous before the "mike," hardly as large as his open hand, and James Kirkwood, veteran actor, actually trembled before it.

Chaliapin, the Russian opera singer, appears before the microphone in his oldest clothes. He says he likes to be comfortable. During a rehearsal he removes his collar and tie. The first time Madame Jeritza, famous prima donna, appeared over the radio, she banished everyone from the studio except the announcer and had the curtains drawn on all windows before she sang. Marion Talley, the young American opera star, takes her radio appearances coolly, undisturbed by the microphone.

I ASKED Phillips Carlin, the announcer who is probably best known for his reporting of important athletic contests, what mistakes an inexperienced person would be most likely to make in his first attempt at broadcasting.

"That's easy," he said. "Number one is 'crowding the mike.' Invariably the beginner gets too close to the microphone. He tries to talk into it as he would into a telephone. As a result his voice 'gets in the mud.' It growls instead of registering perfectly. Another common mistake is talking too fast."

In a studio, seasoned performers always hold their music and manuscripts behind the microphone when they sing or speak before it. Even such a small sound as the rustling of a paper is magnified to the crash of thunder if it occurs close in front of the "mike." For this reason, beads and bracelets which may clink together are barred from the costumes of all the performers.

Talking, of course, is taboo during the broadcasting of a program. As a result a curious system of signs has grown up, to carry messages between the announcer and performers and also between the announcer and the operator listening to the program in the control room beyond a soundproof double window. If you see the announcer shake his fists belligerently at the man on the other side of the window, it merely means that he is inquiring whether the twin disks of the microphones are placed correctly. If he suddenly begins motions like sawing off his own leg, it means that he wants to know whether the cellist is getting across all right. If he twiddles his fingers before his lips, he is merely asking about the clarinets.

More than 10,000,000 American families turn on the radio each evening. Behind the scenes the dramatic and amusing are part of the daily life in this new industry.

A Week in the Air

(Continued from page 22)

dow was sent aloft to replace a broken one and keep out frigid drafts in the cabin. And, every few hours, up came a plane from the earth with a fresh cargo of gasoline to replenish the *Question Mark's* dwindling supply.

It was primarily to test this novel method of refueling in the air that the *Question Mark* made its epochal flight. No one knew exactly how long a plane could stay in the air if fresh stores of gasoline could be loaded aboard it continuously, although in this way two Belgian flyers had managed to stay up sixty hours. So the *Question Mark* and its three powerful motors were groomed for the record attempt and the crew instructed to stay in the air as long as they or the motors lasted.

Forty-five minutes after the take-off came the first crucial test. Overhead soared a small Douglas transport plane with a hundred gallons of gasoline aboard. Observers on the ground saw the two planes, half a mile high, seem to blend almost into one. Then, like a wasp stinging a bird, something that looked like a rod descended from the upper plane and touched the *Question Mark*. For eight minutes the planes flew as one; then the Douglas darted away, grounding a few minutes later, while the *Question Mark* hummed on without stopping.

WHAT actually happened, the flyers revealed on landing, was as follows:

Approaching within twenty feet of the *Question Mark*, the fuel plane flew a perfectly straight course, disregarding its air companion entirely. In the *Question Mark*, the pilot jockeyed his plane in position beneath. When the two were flying together in perfect unison, both zipping through the air at eighty miles an hour, Major Carl Spatz, who received the gasoline, stood on a bench—his head protruding above the fuselage so that he could watch the fuel plane—and signaled for the hose.

Down it came—a two-and-a-half-inch hose, thirty feet long, weighted with a twenty-pound weight to hold it steady in the air. In the *Question Mark*, Major Spatz in a rubber suit and his fuel crew held the nozzle in a funnel that in turn fed the tanks through two four-inch pipes. Another signal, and the aerial filling-station man in the fuel plane turned a valve. Sixty gallons of gasoline a minute raced through the tube into the *Question Mark's* tanks. Refueling completed, the tube was hauled aloft and the fuel plane descended.

Not always did the operation go so smoothly. During a storm the air became so bumpy that almost superhuman effort was required to take on fuel while the two planes were bouncing up and down as much as forty feet at a time.

ALL this time Capt. Eaker sat at the pilot's controls of the *Question Mark*, one hand on the steering wheel and the other on the throttles, gazing intently at the upper plane. He was as calm as a person in a rocking chair watching a spot on the ceiling. Never relaxing his vigilance, he would speed and retard the motors, ready to drop the plane away instantly if danger threatened. Night refueling occurred in the rays of a searchlight under the *Question Mark's* hatch, after the plane had signaled for gas by firing three green pistol shells.

Oil for the plane's motors was delivered in five-gallon cans swung down from aloft at the end of a rope. The same plan served to transfer hot food and messages to the *Question Mark*. In all, the astonishing total of twenty-one tons of supplies including fuel and also such oddities as fur-lined boots and a storage battery were taken aboard in full flight.

Between shifts at the wheel and aiding in refueling, members of the crew found time to write home—sending, via a dropped parachute, the first letters ever written (Continued on page 164)

A definite program for getting ahead financially will be found on page four of this issue.

A Week in the Air

(Continued from page 163)

from mid-air and received while the sender was still in flight. Lieut. Quesada dispatched a note to his mother, while Capt. Eaker forwarded a note to F. Trubee Davison, Assistant Secretary of War, adding "Hope you get this before we come down." He did.

Even newspapers were delivered to the flying hotel by refueling planes. The flyers had the unique experience of seeing news about their flight in print while they were still in the air, and they devoured every new bulletin that was sent up.

When the plane began to pass world marks, one of the two refueling planes soared aloft with a congratulatory message scrawled in foot-high letters on its "blackboard" side. The first mark surpassed was the American refueling record of thirty-seven hours in the air, set five years ago by Army pilots over San Diego; then the Belgian's sixty-hour mark fell. Soon after, the flyers passed the German endurance record of sixty-five hours, which, however, will stand because that plane did not refuel. The *Question Mark* was pioneering in a new class that will be entered as a separate record.

ONLY dirigible records remained to shoot at. At the 111-hour mark the *Question Mark* had been in the air longer than the dirigible *Graf Zeppelin* on its flight from Germany to Lakehurst, N. J.; and at 118 hours in the air the last record had fallen, that of the ill-fated French dirigible *Dixmude*. Then H. J. Adamson, the War Department's representative at the field, sent Secretary Davison a telegram, "Only Elijah has gone farther and longer than the *Question Mark;*" and Davison wired back the laconic message, "Good; let's trim Elijah."

Engine trouble, once bested, finally forced the *Question Mark* to earth. With one motor dead, another streaming oil, the craft landed after a longer voyage in the air than observers had thought possible. Cruising lazily, it had covered a distance estimated to be 11,500 miles—nearly halfway around the earth!

New devices tested in the flight for the first time had proved their utility. One was a sort of lightning rod—a copper wire dropped from the fuel plane to the *Question Mark*, and connected to the metal work, before each load of fuel was delivered. This neutralized electrical charges on the two planes and avoided the possibility of a spark of static electricity that might ignite the gasoline.

A BRAKE for the propellers was another new invention. When one of the engines developed trouble it was stopped and the brake applied to keep the propeller from whirring like a windmill in the air, while Sergeant Hooe climbed out on a precarious "catwalk" and made repairs. Otherwise the spinning blade might have beheaded him. Oil was forced to the rocker arms of the engines by a force pump and special pipe line, tried out for the first time, that made it unnecessary to leave the cabin.

Phenomenal in its success, the endurance test will have a far-reaching effect upon aviation. Army officials see in it the possibility that airplanes may soon be able to fly around the world without stopping, taking on fuel from other planes as they pass airports; or, in mid-ocean, from planes rising from steamer decks on ocean stations. Moreover, military planes can take off with a heavy load of bombs, hitherto impossible because of large gasoline supplies that had to be carried. Commercial planes may carry diamonds and gold long distances without fear of robbery, for no intermediate landing will be necessary. These are but a few of the practical consequences of the flights. What other varied uses await refueled planes, the future will tell.

Back of the Month's News

(*Continued from page 50*)

river itself about ten degrees, all the way from Hell Gate to Governor's Island.

Back of that casual news item lies the interesting possibility that the climate of every large city on the seaboard or the shores of the Great Lakes may be altered materially by the extension of electric power development. It is not impossible that longer growing seasons for food crops in the regions so affected may result, and that crops now confined to the South may be grown in the North, when the production of electricity from coal has doubled or trebled its present volume!

The steam plants generating electric power along the East River burn about 1,000 tons of coal an hour. For every ton of coal burned they must pump 400 tons of water through their condensers, and that water is nearly twenty-five degrees warmer when it goes back into the river than when it was pumped out. When the new state line generating plant on the shore of Lake Michigan, on the border between Illinois and Indiana, is complete, it will raise the temperature of nearly 2,000,000 gallons of the lake's water twenty-five degrees every minute. It will take more heat than that to have an important general effect upon all of Lake Michigan, but it is within the possibilities that Chicago and lake towns as far north as Milwaukee and Grand Haven may some day enjoy a much milder winter climate than at present. Their summers, too, may be warmer, and the annual rainfall greater.

Climate and rainfall are directly influenced by the temperature of large bodies of water. The only sources of sufficient water for steam-electric purposes are the ocean, the great lakes, and the largest rivers, and the only economical places to create power are close to or in large cities on these waters. The net result is that our cities eventually may be steam-heated outdoors as well as indoors.

Longer Range for Planes

TWO little news items whose importance recently escaped the headline writers point toward the next great step in the evolution of flying. That step will be the reduction of the amount of fuel necessary to operate an airplane, making possible much longer nonstop flights. This may result from the application of the Diesel type engine to aviation.

In one of these items, the Packard Motor Company announced that it had built a Diesel engine weighing only three pounds to the horsepower. A few days later the Ford Motor Company reported that its engineers were working on an engine of the same type. Elmer A. Sperry, recently elected president of the American Society of Mechanical Engineers, has just overcome the last obstacle in the way of perfecting a Diesel aviation engine on which he has been working for several years. Nothing, apparently, stands in the way of the adoption of this type of engine for flying except the usual engineering refinements necessary to commercialization.

Diesel engines use low-grade fuels, heavy oil, or distillate. That means cheaper fuel, at half or a third the cost of the high-test gasoline used in modern aviation engines. These heavy oils do not burst into flame as gasoline does. That means that one of the greatest dangers of aviation, fire, is eliminated by their use. Of greater importance is the fact that the heavy oil gives almost three times as much power per pound of fuel as gasoline does. That means a plane can carry more passengers and freight, because less fuel has to be carried in the plane, or a longer flight without refueling.

One of the greatest handicaps the trans-Atlantic flyers have faced is the difficulty of getting off the (*Continued on page 166*)

Back of the Month's News

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ground with the gas tanks full. The machinery of flight is simplified by the Diesel engine, for the charge is fired not electrically, as in the ordinary gasoline engine, but by the heat generated by the high compression of the mixture in the combustion chamber. This does away with magnetos, batteries, spark plugs, and their accompanying wire system, making so much less to get out of order in flight.

Those are some of the advantages of the Diesel engine, once an efficient type light enough in weight is developed. The best air-cooled engines today weigh about 1.8 pounds per horsepower. With the saving in weight of fuel and electrical equipment, a Diesel-type engine of three pounds weight per horsepower might prove equally efficient. Nobody has yet flown a plane with a Diesel engine, but a year from now will doubtless see many in experimental use.

Mining Wealth in the Air

XENON, a rare gas valued at nearly $13,000 a quart, has been extracted from the air by the French physicist, Georges Claude. In the air we breathe only one part in ten million is xenon. Its uses are to be found only in technical laboratories.

As the treasures of our planets, such as ore and gems, become exhausted, men give more attention to mining the air. More than $10,000,000 worth of treasure swirls unseen above every acre on this earth. One by one the problems of extracting them are beginning to be solved.

Other than oxygen, without which all life would perish, the most important gas in the air is nitrogen, a necessity in the fertilization of plants. The use of the practically inexhaustible stores of this gas in the atmosphere to supplement the inadequate amount in the earth will mean much to agriculture. With enough nitrogen fertilizer, fifteen bales of cotton and 1,100 bushels of corn could be raised to the acre.

Methods now used to obtain nitrogen directly from the air are costly. Nevertheless, one American company reported extracting $10,000,000 worth of chemicals from the atmosphere in twelve months. But a cheaper and quicker method of mining the air will bring its discoverer vast riches.

Hair-Splitting the Inch

"DIVIDES the Inch into Millionths" is the headline over a news item from Washington, describing a device invented at the Bureau of Standards for making minute measurements by means of light rays.

From 1631, when Pierre Vernier invented a device to enable anyone to divide the inch into thousandths, the effort to reduce measurements to still smaller fractions has been continuous. Up to Vernier's time a sixty-fourth of an inch, measured with a carpenter's steel rule, was the smallest dimension used. The Vernier method is still used in every machine shop. A few years later William Gascoigne invented the micrometer for use with the telescope, which gave still finer divisions of space. Now, however, even the exact thickness of an atom, a fraction so inconceivably minute as to be unimaginable, can be determined by a measuring device used in the Bell Telephone Laboratories.

Measurements such as these are not merely laboratory amusements. Astronomers, for example, use units of a quarter of a billionth of an inch in determining the distance from the earth and the size of heavenly bodies. So delicate are some of these devices that it is possible for an astronomer to measure the diameter of a pinhead sixteen miles away!

Once Edison Was an Editor

(Continued from page 32)

"sixing" seriously interfered with young Edison's plan of life. How was he to get any sleep if he stayed awake at his key all night and plugged away at his experiments all day? So he devised a small wheel which he attached to the office clock and the line. The wheel had notches in it and at night when he hooked the line up with the circuit, the clock automatically completed the circuit every hour, the wheel revolved, and automatically sent dots and dashes which spelled "six," while Edison napped.

The invention was a success. But the dispatcher noticed that often when he tried to get Edison on the wire, even immediately after the signal had been received, he couldn't raise him. Investigation revealed Edison's ingenious device. A reprimand followed, but Edison didn't lose his job.

EVEN in those days Edison refused to be "stumped" by any problem confronting him. It was his power of overcoming obstacles that put him among the pioneers of "wireless telegraphy." One day in the winter of 1863–64 an ice jam broke the telegraph cable in the bed of the river between Port Huron and Sarnia, paralyzing communication between the two towns. It was impossible to cross the three-quarter-mile stretch of ice and water by boat or afoot, and there were no telephones. The situation seemed hopeless, until Edison proposed that they use a locomotive whistle to send messages in the Morse code. The signals worked and thus was the first "wireless" established.

While working as a telegrapher, Edison enjoyed playing jokes on his fellow operators, fitting up battery circuits to "sting" them, and devising many schemes to mystify his office companions. Once he built a "rat annihilator" to electrocute vermin that infested the building. This simple contrivance consisted of two plates insulated from each other and connected with a main battery. They were so placed that the circuit was completed the instant a rat placed his forefeet on one plate and his hind feet on the other. When Mr. Rodent got in that position the fractional seconds of his life were numbered.

IN INDIANAPOLIS, Cincinnati, and then in Boston, Edison worked as a telegrapher for the Western Union. In Boston he worked and experimented from eighteen to twenty hours a day. His cronies were a number of practical investigators and electrical workers, including the late Charles Williams who afterward became an associate of Alexander Graham Bell, inventor of the telephone. Edison conducted most of his experiments in Williams' electrical workshop. There he made a working model of his first patented invention, a vote recorder, the patent itself being taken out June 1, 1869. This invention, intended to permit a vote in the House of Representatives in Washington in about one minute, thus eliminating the vast waste of time that was then, and is now, the custom. When he exhibited his contrivance before a committee the chairman said, "Young man, if there is any invention on earth that we don't want down here it is this. One of the greatest weapons in the hands of a minority to prevent bad legislation is filibustering on votes, and this instrument would prevent it."

Edison accepted his "defeat" gracefully. Never since that day, however, has he exercised his inventive faculties on anything for which there is not a real, widespread demand.

Before leaving Boston, Edison invented a stock ticker and established a ticker service with about forty subscribers. He also put up private lines, using an alphabetical dial instrument for telegraphing between business establishments. This was a fore-

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Once Edison Was An Editor

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runner of the modern dial telephone. In fact, Edison's activities became so diversified that he determined to invade New York. At that time he was deeply in debt for his new inventions, but his courage and hopes were high. He went to New York in 1868, made an unsuccessful attempt to market his early stock printer and, being in financial difficulties, returned to Boston.

Undismayed he went to work on a duplex telegraph for sending two messages over a single wire simultaneously. When this was finished he had a little money left from $800 he had borrowed to build the instrument. With this he went to Rochester, N. Y., to test the apparatus on the telegraph lines between that city and New York. But because an assistant in New York failed to understand the minute instructions Edison had written out, the experiment was unsuccessful.

WITH his purse so badly depleted he could not pay his debts he was forced to leave his books and instruments behind while he went on to New York. When he arrived in the metropolis Edison didn't have breakfast money. While walking the streets he saw a man in a wholesale tea house "tasting" tea. Going in he asked if he might have some. His request was granted, and the first breakfast in New York of the man who now could, if he would, be the guest of honor at daily banquets, consisted of tea and nothing but tea.

He slept in the battery room of the Gold Indicator Company. This company was in possession of a system of indicators invented by Dr. S. S. Laws, which showed the fluctuations of the gold market. While waiting for a promised job Edison studied these indicators and the complicated transmitting instrument which was operated from the floor of the Gold Exchange.

One day—the third after his arrival in New York—he was watching the instrument when, right in the busiest moment of trading, something snapped. Within two minutes the exchange was in wild excitement. Scores of brokers in their offices were cut off from communication with the "board." In a few minutes hundreds of boys came running into the exchange all yelling for a man to repair the machine in their employers' offices. The man in charge of the machine got so excited he forgot all he knew about the instrument.

EDISON went to the machine and, having already studied it thoroughly, quickly discovered what was amiss. One of the many contact springs had broken off and had fallen down between two gear wheels. Edison started to tell the man in charge of the indicators what was wrong when in came Dr. Laws. The doctor excitedly demanded of the operator what was wrong. The latter was speechless. Edison walked up to Laws, saying, "I know what's wrong."

"Then fix it! Fix it!" cried Dr. Laws.

This Edison did in a couple of hours. Laws then asked him to come to his private office next day. At this meeting he put Edison in charge of the whole plant at a salary of three hundred dollars a month. Edison could hardly believe his ears. Never before had he received more than half such a salary.

While with the Gold Indicator Company Edison and Franklin L. Pope became friends and finally business partners. Soon Edison devised a stock printer to print gold quotations instead of indicating them, which was bought up by the Gold and Stock Telegraph Company. After this sale General Marshall Lefferts, president of that company, commissioned Edison to work on improving the stock ticker. As a result Edison produced the "Universal" ticker, widely

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Once Edison Was An Editor

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used in its day, and many related inventions.

Up to this period Edison had been in financial difficulties more often than with money. Often he had scarcely enough to buy the necessities of life, and an extra suit of clothes was a luxury. Always a poor business man, he was unprepared one day when General Lefferts called him into his office and said, "Young man, I want to close up the matter of your inventions. How much do you think you should receive?"

Edison did some quick mental arithmetic. He thought of the time he had spent working for Lefferts and figured everything was worth about $5,000. He guessed, to himself, however, that he could get along with $3,000. But, not having the courage to ask this "huge amount" he said, "Well, General, suppose you make me an offer."

"How would forty thousand dollars strike you?" asked Lefferts.

It struck the young inventor so hard, he afterwards confessed, that he almost fainted.

"I think that's fair," he managed to say at last, and three days later Edison received a check for that amount. For the first time in his life he had a bank account! And he was twenty-two.

RELIEVED of financial worry Edison went into business for himself. He bought machinery, opened a small shop, and started turning out stock tickers and other electrical instruments. Business increased rapidly. He moved to larger quarters and soon was working eighteen to twenty hours a day, inventing, making chemical experiments, and directing the force of 150 men he employed.

It wasn't long until Edison had several shops in operation and was working on forty-five different inventions. He made thousands of experiments on a system of automatic telegraphy which he eventually perfected. When this was well established in America he introduced it in England. The quadruplex system of transmission, which has saved more than $20,000,000 in the cost of line construction, next claimed his attention. It required tremendous concentration. One day as his mind was engaged in the problem, Edison set out for the tax receiver's office in Newark, N. J., to pay his taxes. Arriving at the City Hall he subconsciously fell in line before the collector's window. When his turn came, the man behind the wicket asked, "What's your name?"

EDISON looked blankly at the man. "I—I don't know!" he admitted.

"Next!" exclaimed the collector.

A few seconds after he lost his place in line Edison remembered who he was, went to the foot, and worked up again, every few seconds telling himself he was Thomas Alva Edison. Edison knew how to concentrate!

In 1876 Edison began experiments on the telephone. Alexander Graham Bell had invented the first telephone. It resembled the present receiver but was used both as transmitter and receiver. Because of the faintness of the voice and the extraneous sounds which came in on the wire, however, attempts to commercialize it had failed. The Western Union asked Edison to see if he could make the telephone commercially practicable. In a very short time he produced the carbon transmitter, now universally used. A Hungarian, Theodore Puskas, suggested a telephone exchange and soon after this was put in operation. The Bell Company, of Boston, also started an exchange and "the fight was on." Edison began wondering where he came in. He hinted to President Orton of the Western Union that he would like some sort of settlement. One day Orton sent for the inventor and asked him

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A definite program for getting ahead financially will be found on page four of this issue.

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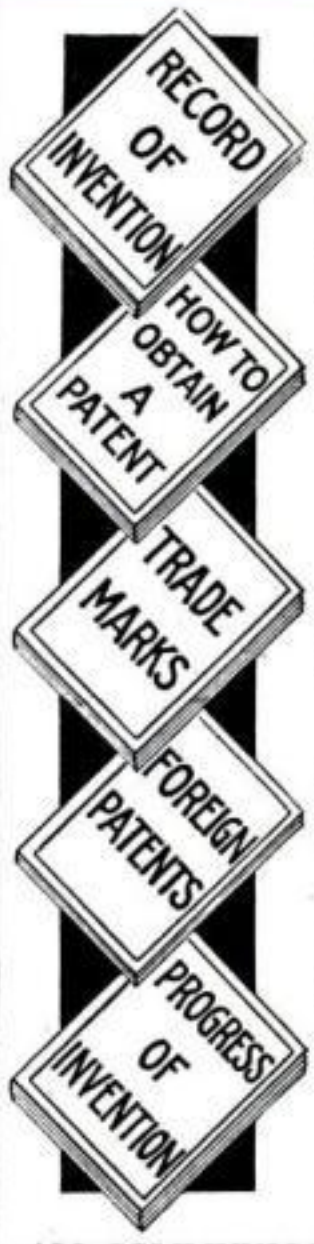

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Once Edison Was An Editor

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how much he wanted for work he had done.

"I had made up my mind it certainly was worth twenty-five thousand," says Edison. "I recall, too, that I made up my mind to stick obstinately to that figure until I got it. But as I neared his office it seemed to me that what I had done had been easily accomplished, and I felt a bit shaky and uncertain about asking for so much. So, as I had done in selling my inventions to the Gold and Stock Telegraph Company, I asked Orton to make me an offer.

"'One hundred thousand dollars,' said Orton.

"'Sold,' said I, 'on one condition, and that is that you do not pay it all at once, but at the rate of six thousand dollars a year for seventeen years, the life of the patent.'

"Orton readily agreed and the deal was closed. I had made that stipulation because my ambitions were about four times too large for my business capacity. I knew I would soon spend all this money experimenting if I got it all at once. I saved seventeen years of worry by this stroke."

IN 1877 Edison got a big laugh out of his employees at Menlo Park, N. Y., when he announced that he was making a machine to reproduce human speech.

One of his foremen bet him a box of cigars it couldn't be done. Edison just smiled and continued working on what he called a phonograph. He designed a little machine on which was a cylinder with grooves around the surface. Over this was to be placed tin foil which easily received and recorded the movements of a diaphragm. He made a sketch and turned it over to John Kruesi with instructions to make the machine. Edison estimated the cost would be $18.

When Kruesi had nearly finished the work he asked Edison what it was for. The inventor told him he was going to record talking and then have the machine talk back. The workman looked at the inventor to see if he was "spoofing." A few days later the machine was placed before Edison. Though he didn't hope to get back much more than a word, he shouted "Mary had a little lamb." He then adjusted the reproducer and started the machine.

"Mary had a little lamb" came the voice from the machine, Edison was so amazed he almost fell out of his chair.

Kruesi, dumbfounded, exclaimed, "Mein Gott im Himmel!" while the other workers joined hands and danced around Edison shouting with glee.

THE "talking machine" immediately became a public sensation and was exhibited to great crowds throughout the country.

Since then Edison has made many improvements in the crude little machine that first "talked back to him." He has never lost interest in this invention and even today often spends many hours seeking further improvements on it.

Of all his inventions the one which has proved of greatest value to the world is the incandescent lamp and the complete system Edison developed for the distribution of electric light, heat, and power.

When Edison began work on this subject the arc light was in operation to a limited extent, but the vast problem which remained unsolved was the economical utilization of the electric current. He approached his task with great energy and reckless disregard of financial cost. With carbon as a base he experimented with hundreds of substances, in the effort to discover a tough, thin-as-hair filament for a light-giving body that could be maintained at a white heat for a thousand hours before breaking, and yet (Continued on page 173)

Once Edison Was An Editor

(Continued from page 172)

so cheap as to place it within reach of all.

During his investigations he carbonized everything from fishline to human hairs. Those who know the story suspect that Edison was merely indulging his penchant for fun when he used hairs from a friend's beard to "aid in the experiments." J. U. Mackenzie, the man who years before had taught Edison telegraphy, was visiting the Edison plant at Menlo Park one day when the great inventor was working hardest on the electric light. Mackenzie had a luxuriant red beard. Edison requested his old friend to contribute a few strands for experimental purposes. Mackenzie reluctantly parted with a few hairs and they were carbonized and used for filament. When the lamps were lighted the "boys," as Edison called his workmen, gleefully assured Mackenzie that their brightness was due to the rich, ruddy color of the hairs.

ON OCTOBER 21, 1879, after countless experiments, a lamp had been invented which, when put on the circuit, lit up to illuminating incandescence, and maintained its integrity for forty hours. The greatest invention of the century was accomplished.

"A most beautiful accident" was the way Edison described the "ditching" of the first practicable electrically operated train—his own—at Menlo Park in 1880.

The mishap occurred on one of the curves of his third-of-a-mile track as the train was "rushing" along at forty miles an hour. Writing to a friend about it, the late Grosvenor P. Lowry, friend and legal adviser of Edison, said in a letter dated June 5, 1880:

"The train jumped the track on a short curve, throwing Kruesi, who was driving the engine, with his face down in the dirt, and another man in a comical somersault through some underbrush. Edison was off in a minute, jumping and laughing, and declaring it a most beautiful accident. Fortunately no other hurts were suffered, and in a few minutes we had the train on the track and running again.' '

When Edison had this new invention ready he showed it to the division engineers of the Northern Pacific Railroad at the request of Henry Villard. These gentlemen voted unanimously that it was absolutely and utterly impracticable. Yet, that system is used today on more than one of America's great railways.

AFTER perfecting the electric railroad system Edison contributed hundreds of other inventions which are widely used. In 1887 the idea occurred to him that it was possible to devise an instrument which would do for the eye what the phonograph had done for the ear, and that by a combination of the two, motion and sound could be recorded and reproduced simultaneously. Two years later he turned out the first motion picture camera—a camera which to this day is the accepted standard for obtaining pictures of objects in motion.

The first pictures made in the yard of the Edison laboratory, then at Orange, N. J., were such simple ones as Carmencita dancing, performing bears, fencing matches, Fred Ott's sneeze, and feats in horsemanship. Once a New Jersey aspirant for pugilistic honors—and publicity!—agreed to a four-round go with James J. Corbett in front of the camera. Corbett made the journey to Orange all prepared for the bout, but when the local bruiser saw Gentleman Jim he remembered an engagement he had elsewhere. He hasn't been heard of since.

Still vigorous at eighty-two years, the Wizard of Menlo Park continues to provide newspapers throughout the world with material for their annual heading:

"EDISON WORKS
ON BIRTHDAY."

Science Takes Stock of Its Conquests

(Continued from page 29)

an instinctive sense of pace, defeating others of greater muscular power and better form. Timing can be taught, but it is harder to learn than form and is forgotten easier.

METEOROLOGY

THE United States Weather Bureau is establishing a weather reporting service for aviators along the 14,000 miles of established airways, the service including reports of upper air conditions obtained by means of captive balloons, Willis R. Gregg of the Bureau reported. Fifty upper-air service stations have been established and 150 stations to report surface conditions. The reports cover wind direction and force, visibility, height of cloud banks, fogs, and storminess, and at present are sent out at times regulated by the regular schedules of the mail and passenger air services. Pilots now get these reports from the ground before starting, but as soon as enough planes are equipped with radio the Weather Bureau will supply a continuous radio weather report service which can be picked up in flight.

A single "norther" recently cooled the water of the Gulf Stream from 80 degrees to 77 where it flows through the Florida Straits, Professor Charles F. Brooks of Clark University reported. Science is studying the effects of storms on surface water temperatures because these temperatures, in turn, affect the climate of the adjacent shores and even of distant countries. Adequate knowledge of changes so produced may aid in long-distance weather forecasting.

SOCIOLOGY

DECLARING that "sin is scientifically indefinable and unknowable," Dr. Harry Elmer Barnes, professor of sociology at Smith College, threw a monkey wrench into the smooth-running machinery of the Association's meeting by calling for a new concept of God "in the light of contemporary astrophysics, which completely repudiates the theological and cosmological outlook of the Holy Scriptures."

President Henry Fairfield Osborn of the A.A.A.S. officially rebuked Dr. Barnes for dragging religion into a scientific meeting, but the teacher of young women stuck to his guns. He urged the need of a valid basis for new rules of conduct that will rest squarely upon scientific foundations.

Dr. Harry Emerson Fosdick, noted New York preacher, responding to the challenge of Dr. Barnes, declared that "the foremost religious minds are becoming more scientific and the great scientific minds more religious. . . . . The major effect of science is not theoretical but practical. It gives us control of life. It furnishes us with instruments to produce change. The will of God is not something to be submitted to, but something to be worked out."

BIOLOGY

LIFE can exist in interstellar space; therefore it is possible that living germs may be transmitted to earth from other planets. So Dr. Frank E. Lutz, of the American Museum of Natural History, concluded from experiments with insects, which he reported. Tested in a vacuum, the insects not only lived without air but some of them seemed to gain energy.

Animals which can be divided and subdivided into 10,000 pieces, each piece continuing to live and develop into a perfect animal, were described by Prof. Wesley E. Coe of Yale. The animals are a variety of sea worms.

Magnetism has an effect on life, Dr. A. A. Schaeffer of the University of Kansas reported. He placed one-celled animals, amoebae, in glass tubes placed within the field of powerful electromagnets. The animals were stimulated to increased activity.

Crickets fiddle for fun and not to attract mates, Dr. Frank E. Lutz, of the American Museum of Natural History, reported. He caged some female crickets next door to males which had been mated mute, and found that these were just as attractive to the females as those who fiddled.

X-ray treatment of plants causes a change in the species produced from their seeds, Dr. T. H. Goodspeed and Dr. A. R. Olson of the University of California reported. Dr. Frank Blair Hanson of Washington University stated that he had found that radium emanation produced the same effects.

GEOLOGY

IF IT were not for asthenoliths we would still be swimming in the sea instead of living on dry land, said Professor Bailey Willis of Stanford University. An asthenolith, he explained, is a rock blister on the earth's crust. All continents and most islands are founded on blisters, through which, as they burst, the lighter materials of which the earth is made flowed in molten streams until they got above water. The crust in which these blisters form is about 2,000 miles thick; inside is an incompressible core about 4,000 miles in diameter, very hot and fluid and with the density of iron.

Blisters are still forming, causing earthquakes and volcanoes, and new islands and continents may arise in time, Professor Charles Schuchert of Yale said. The Gulf of Mexico is only a hundred million years old, he explained, formed by the blisters which became Costa Rica and Panama on the west, the Caribbean islands on the east.

Falcon Island, in the Pacific, is one of Nature's efforts to form new land, said Professor J. Edward Hoffmeister and Harold L. Alling of the University of Rochester and Professor Harry S. Ladd of the University of Virginia. They visited this South Pacific volcano last summer, two weeks after a violent eruption. It is two miles in diameter and 365 feet high and has twice disappeared, its third appearance having been made in October, 1927, when it popped up and burst like a boil on the face of the earth.

The earth is nearer a billion years old than half a billion, Professor Alfred C. Lane, of Tufts College, reported. Physicists have come to that conclusion by measuring the radioactivity of the oldest rocks, and geologists by computing the amount of salt carried to the ocean by rivers and flood waters.

AGRICULTURE

A PLAIN, white, ordinary sunlight is better for growing crops than any kind of "filtered" light, Dr. Hardy L. Shirley, of the Boyce Thompson Institute for Plant Research, reported. He described a new instrument he has devised for measuring the natural light in a field. It converts the energy of light into an electric current which can be measured.

Dr. L. O. Howard, of the Bureau of Entomology of the U. S. Department of Agriculture, told of an American bug-hunting bug that is being sent all over the world to destroy parasites which ruin apple orchards. Its name is Aphelinus mali, and it is now spread more widely over the world than any other beneficial insect except the honey bee.

The Japanese beetle, dreaded pest of gardeners in the Eastern states, is a geranium addict, and can be (Continued on page 175)

Science Takes Stock of Its Conquests

(Continued from page 174)

induced to commit hara kiri by supplying it with plenty of geranium leaves to feed on, reported Charles H. Ballou of the U. S. Department of Agriculture. Though it is poisoned by geranium, the beetle has not the will power to resist eating the fragrant leaves.

BOTANY

ASPIRIN has no effect in keeping cut flowers alive, A. E. Hitchcock and P. W. Zimmerman, of the Boyce Thompson Institute for Plant Research, reported. Putting an aspirin tablet in a vase of cut flowers is a common practice, but neither that nor any of forty-three other chemicals with which tests were made has any effect.

Chloroform has no effect upon the "sensitive plant" which folds up its leaves when touched, Dr. Raymond H. Wallace of Columbia reported. Ether, however, affects it much as it does human beings.

Dr. Grace H. Griswold of Cornell University, reported that the geranium aphid, one of the plant-lice which plague florists, has an enemy in a secondary parasite which feeds upon the aphid's life-juices, and which is, in turn, preyed upon by a third parasite of even more venomous quality. She suggested that there may be as yet undiscovered fourth, fifth and other parasites, "ad infinitum."

GEOGRAPHY

THERE is still a huge proportion of the earth's surface about which geographers have no exact information, and the rest of the world is changing its character more rapidly than ever before, the American Geographical Society reported.

Among achievements reported for the year were airplane surveys in the Canadian Northwest, on the Zambesi River in Africa, and in Rio de Janeiro, Brazil.

The Canfranc-Somport railway provided a new and better route over the Pyrenees; the Cascade tunnel, eight miles long, 100 miles east of Seattle, was completed, the longest tunnel in America; Central Africa was further opened up by the extension of railways.

Captain Sir Hubert Wilkins flew over the North Pole and disproved the existence of land north of the Canadian Archipelago; then went toward the South Pole and reported the absence of any connection between Graham Land and the Antarctic continent. Commander Byrd started his journey of exploration with the South Pole as his objective.

FORESTRY

NEARLY seventy percent of all feed for livestock in eleven Western states comes from grazing privileges in the National Forests, reported W. R. Chapline, of the U. S. Forest Service. By application of scientific research, the productivity of these forest lands has increased about twenty-five percent in the last fifteen years.

Scientists are paying too little attention to the study of parasites which destroy shade trees, Dr. E. P. Felt, of Stamford, Conn., complained. The gypsy and browtail moths have almost ruined New England's stately elms, including the famous Washington Elm at Cambridge.

Sparks from logging and railway engines are responsible for a high proportion of forest fires, though not for so many as the campfires of careless tourists and the discarded cigarette, said Prof. A. C. Coonradt of New York University.

I Am Learning to Be a Flyer

(Continued from page 19)

who noted it down, and to me: "That means you can read letters at twenty feet that you ought to read at twenty feet. You have good vision."

"Good enough for a transport pilot?" I anxiously wanted to know.

"We shall see," he answered, and walked to the end of the room. "Come here, please." I went. Beside the optical chart were a number of little cards. Each was spattered with colored round dots, some pink, some gray, some green, some a mixture. Among the colored dots on each card was a numeral. Some were easy to read, such as a red numeral against a green background. Others were harder, such as a pale gray number against a grayish-green background.

"Start at the top," the doctor directed, "and read as many as you can."

I did. I could read them all.

"WITH these cards," he explained, "we find out whether or not you are color blind. We have men come in here who have been color blind all their lives and never knew it. One prospective pilot was chatting with me when he suddenly mentioned the pretty brown ash tray over there."

"The green one?" I asked.

"Yes. It was brown to him—his favorite shade of brown. I couldn't pass him. Another applicant, after failing to pass this test, said that an amusing puzzle was at last explained. He said he was fond of neckties of a certain deep maroon shade. Whenever he bought and wore one, his friends mystified him by asking him why he was celebrating St. Patrick's day so far ahead of time! Now," said the doctor, "we're going to find out how well you judge distance. This is the way we do it." And he indicated the strange looking apparatus I had seen when I came in.

"In the early days of flying," he went on, "there was no test for a flyer's ability to judge distance. More flyers died in crashes because they lacked that faculty than from any other cause. This little machine is a yardstick for measuring your depth perception."

I EXAMINED the machine with great curiosity. It reminded me more than ever of a little stage set on four long wooden legs. The stage was empty except for two iron rods about eight inches long which stood side by side like actors. One of the upright rods was fixed to the floor of the stage, the other was fixed on a strip of wood which moved forward and backward in a slot. The doctor told me to sit down in the chair at the other end of the room, facing the little stage and its two iron actors. In each hand I held a string. The two strings stretched from where I sat to the stage, twenty feet away. By pulling one string, the movable iron rod was drawn toward the front of the stage; by pulling the other, it was drawn toward the back of the stage.

Is that explanation clear? The doctor pushes the movable bar to the rear or to the front of the stage. Then you, with the strings in your hands, move the bar toward you or away from you until it *looks* as if it is exactly opposite the stationary bar.

Between the bars is a pointer and a scale marked in millimeters. Three times you must adjust the movable bar until it appears to be abreast of the stationary bar. Your average is taken from the three trials. If your average error is more than thirty millimeters, you cannot become a flyer. My average, to my great surprise, was twelve millimeters.

I was sure that the worst was now over—but it wasn't. Next came the perimeter test. With this instrument the doctor found out all about my ability to see objects not in the direct line of my vision. While I stared at a tiny round mirror in the center of a semicircular bar of gun metal, the doctor slid a black disk slowly toward the mirror. On one side of the disk was a red spot; on the other, a blue spot. I stared at the tiny mirror, and when the spot became visible I called the color.

It is necessary for a flyer to have good peripheral vision, so that he can see planes or other objects off to one side, or above, or below, when his gaze is fixed on some object straight ahead—for example, the field in which he is about to land.

Next came the phorometer test. The phorometer is a complicated, delicate optical instrument containing lenses, prisms, and other gadgets far beyond my understanding. I was told to look through the phorometer at a pinhole of light. With one eye I saw the pinhole; with the other, a horizontal streak of light which ran through the pinhole. Then a red lens was placed over each eye in turn while a series of prisms were held before the other until a red pinhole and a white pinhole parted company. Dr. Francis explained that these were eye muscle tests. A flyer must be able to adjust his focus quickly from far to near and vice versa—be able to see a distant landing field or landmark clearly one moment and his instrument board the next. And he must not have double vision.

"A MAN with double vision would, after many hours of flying," said the doctor, "see two things where only one ought to be. His eyes might even be crossed from the strain. I would not care to be that pilot's passenger when he tried to land in a small field!

"One young man proved, when I examined him, to have double vision. He was mad about flying, and asked if his defect could be remedied. I suggested an operation on his eye balancing muscles. He had it performed, came back again, and passed this test with ease. He is a very successful flyer. You have good eye muscles."

I was relieved to know it, and I was beginning to understand why twenty-five of every hundred men who came into this room were disqualified. I had never dreamed that flying demanded so many different qualities.

I asked Dr. Francis what kind of men make the best pilots.

"Everybody connected with aviation," he answered, "has his own opinion. An expert automobile driver, some say, makes the best flying student. Others say a violinist makes a good flyer because his fingers are so sensitive. Others say horsemen. Still others favor tennis players because of their quick eyes and coordination. I would be inclined to say that an expert billiard or pool player should make a good flyer. He must have fine eyesight, an excellent judgment of distance, and a nervous system at all times well under control."

"DO YOU know any expert pool players who are expert flyers?" I wanted to know. But Dr. Francis knew of none. This led to the question, "What kind of people come here to be examined?"

"All kinds. Rich men, poor men, tall men, short men, nervous men, stolid men, taxicab drivers, clerks, athletes, mechanics. I am trying to keep a record of them all, to ascertain if any type of occupation is the best for fitting a man for flying.

"In one afternoon, I examined a bank president and a bootblack. I understand the bootblack is a better flying student than the banker. He shines shoes until he has enough to pay for another lesson. He is determined to fly the night mail. I think he will.

"Many men who sell airplane stocks and accessories take up (Continued on page 177)

I Am Learning to Be a Flyer

(Continued from page 176)

flying for the prestige it will give them in their business."

"Many women?" I asked.

"One in twenty," he answered. "I suspect that many of them take up flying because it is, at present, the thing to do. I recently examined a French milliner. She is married, has five children, works from eight to four, goes to night school three or four evenings a week to perfect her English, and somehow saves enough and finds time to take flying lessons. She is game and a good sport. A game sport makes a game flyer. Now let's try your hearing. Stay where you are."

Dr. Francis walked to the end of the room and told me to repeat what he said. His whisper came floating to me: "Sixty-six. Eighteen. Twenty-three."

I heard without difficulty. He mentioned, as I accompanied him into the X-ray room, that a flyer's hearing is not nearly so important as his vision. He must be able to hear his mechanic say "Contact" or "Switch off," and, in some classes of flying, radio signals.

In the X-ray room I was told to strip. When I had stripped, Dr. Francis took my blood pressure and pulse. I was afraid my pulse was much too high. It was! But so is that of everyone who takes the examination. A man's normal pulse is around seventy-two. Mine was eighty-eight. But it came down almost to normal after I had hopped around the room on one leg.

AFTER a thorough inspection of my eyes, ears, nose, throat, and body generally with different kinds of lights and instruments, the doctor turned out all the lights, backed me against an X-ray machine, and looked at my heart and lungs on a fluoroscopic screen. Heart was O. K. Lungs showed no signs of tuberculosis.

I ventured the opinion that a tubercular flyer might make a perfectly good flyer.

"The object of all these tests you've taken," the doctor answered, "is to weed out trouble before it happens. You've passed through a sort of sieve. I am satisfied and the Department of Commerce will be satisfied when I submit my report on you, that you aren't apt to get your name into the papers by cracking up a plane. Your eyes are good. Your nervous system is well balanced and responsive. You haven't been weakened by sicknesses. We don't want men to go into the air and betray some unexpected weakness at a crucial moment. We're trying now to prevent accidents before they can happen. There is no reason, in my mind, why you should not make a fine pilot. Follow me, please."

I followed him, and I wouldn't have exchanged my sensations for a million dollars.

We returned to the little office which, just an hour before, I had entered. The girl at the typewriter looked up with a smile.

"Another Lindbergh?" she asked—and when she saw the expression on my face, reached into a drawer for a mimeographed sheet of paper. She put it into the typewriter, filled in my name at the top, and the doctor signed the document.

I was much prouder of that letter than I had been of my high school diploma. It was a very satisfactory answer to the question I had asked when I hesitated with my hand on the door knob. I was physically fit to fly!

Tomorrow morning I'm going out to Curtiss Field. I'm going to enroll. Maybe I'll have my first airplane ride.

Next month you'll ride with Brent on his first flight in an airplane. And from his vivid, stirring description, you'll experience with him all the feelings of a novice grasping the controls for the first time in his life. A great story! A thrilling story! Don't miss it!

Scotty Allan

(*Continued from page 27*)

I hopped out of the car I was in; hit the ground running and didn't stop until I reached the scene of carnage.

They were my dogs. That is, I had brought them all the way from Nome, across Canada and the Atlantic Ocean in 1915, for the French Government to use in carrying supplies and ammunition through the steep passes of the Vosges Mountains in the early stages of the World War.

When we got out of the ship at St. Nazaire I had my animals put in an inclosure surrounded by a high fence. They badly needed exercise after weeks of being cooped up on railway train and ship. Of course I had them tied to rows of long lead lines, letting a few loose at a time to prevent trouble.

WHILE I was down in the village making a few purchases the Frenchmen, misunderstanding my orders, let all the dogs loose at once. Naturally it was a fine chance for the beasts to settle then and there a lot of feuds and grudges that had grown up on board ship. About fifty flew at each other's throats. The four hundred others let out a grand yowl of joy and joined in on either side of the fray, they didn't care which.

When I got there the Frenchmen were dancing around the outside edge of the battle, waving their arms and yelling. They were making almost as much noise as the dogs were. I think they were afraid the dogs would all kill one another; and at the same time not one man knew enough about dogs to dare jump in and try to save any.

It took me at least five precious minutes before I could do anything about the Frenchmen. They couldn't speak English and I knew only four words of French, none of which had anything to do with dog fights.

Finally I got the Frenchies unscrambled and stationed near the lead lines.

Then I took my long rawhide whip and approached the mountain of murdering dog flesh. The piles were higher than my head; and though I can crack my whip nearly as loud as the report of a pistol I couldn't hear the lash pop when I swung it over that roaring mass of huskies.

IF THE dogs didn't hear it, they certainly felt it. One by one I rolled them out of the fight with a cut of my whip and sent them howling toward their kennels. As individual dogs fled with their tails between their legs the Frenchmen caught and snapped them to the lead lines. In almost less time than it takes to tell the fight was over and all except a score of worst casualties had left the field of carnage. In some ways that was the greatest battle of the whole war. I am told the Frenchies still speak of it with excitement.

A team will pull its heart out when its master also has his heart in the job.

I can see how an angry contractor standing in front of me on the beach at Nome and bawling:

"You bet they can't pull it! No dog team alive could. No, nor *two* dog teams either!"

"Maybe, maybe," was all I could say, trying to hold my temper.

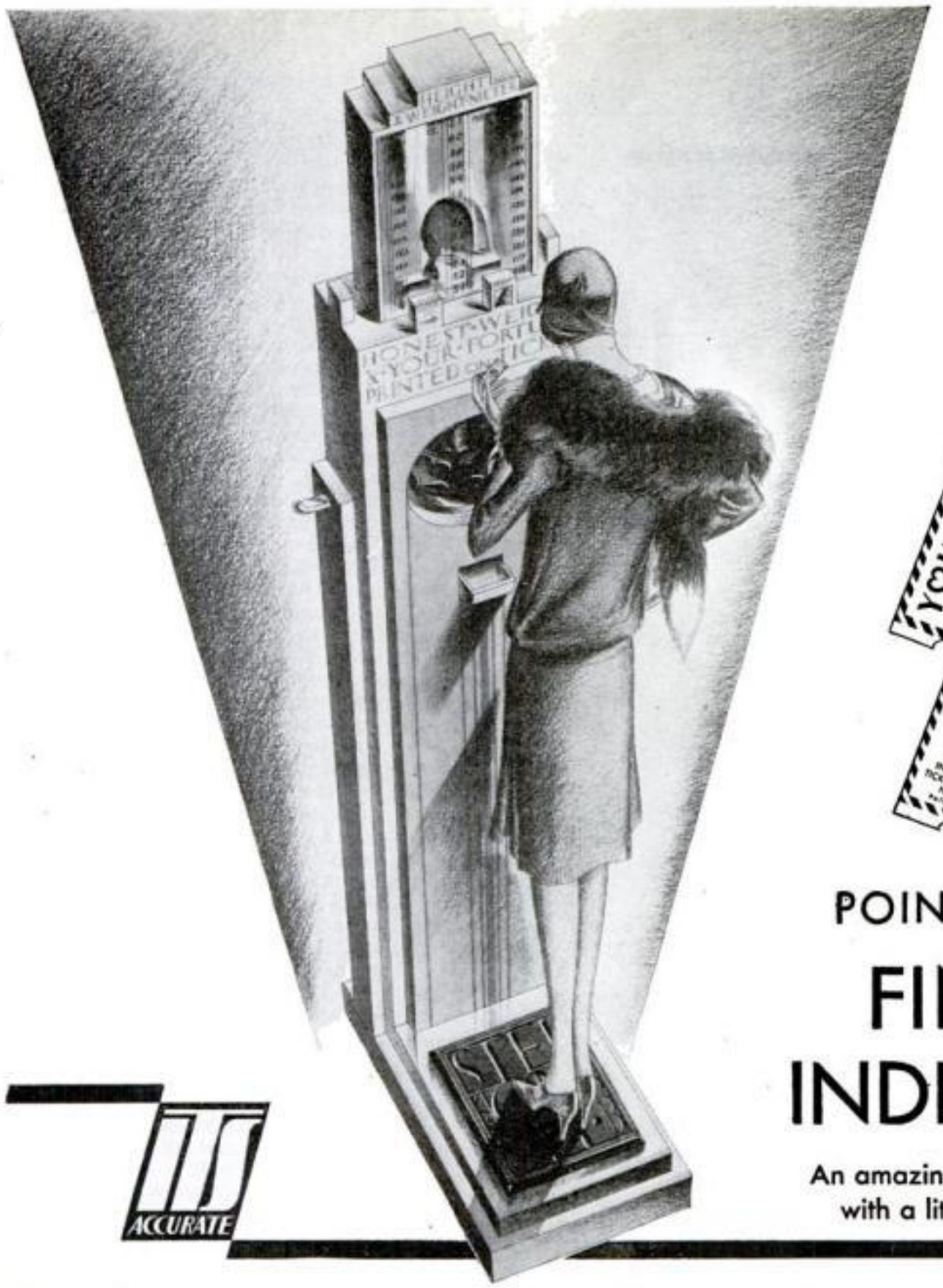
"'Maybe,'" he mocked me. "Maybe they *couldn't!*"

Gosh, that fellow was sore. He was so sore that he made me sore, too. But it was the way he cast aspersions on my team that I couldn't stomach.

What had happened was that the Superintendent had begun to kid the contractor because the latter's team of horses couldn't pull a big hand car loaded with iron pipe up the beach slope to the warehouse.

"Why, if Scotty only had his dogs here, he'd do the job!" he told him.

As the team was (*Continued on page 180*)



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Scotty Allan

(Continued from page 178)

doing its level best, the contractor blew up at this. His horses hadn't even been able to start the car, much less move it up the hill.

The row stopped all other work. A crowd gathered around and there was nothing for me to do but get a dog team down there and decide the bets that were springing up. It was either that or there'd be a free-for-all fight between those who backed the horses and those who backed the dogs.

I had only five dogs in shape to work at the time. But there weren't five dogs in Alaska that could beat them. They were not big dogs; rather small and stocky, but with muscles like bundles of steel wires; and in a tussle they'd stand behind me till the cows came home.

"CAN you really do it?" whispered one man while I was hitching up.

"Sure," I told him.

He ran right out and put up another hundred dollars on my team!

When I told the leader to "tighten up" he laid against his breast band with the others and "felt" the load. A plank had been laid lengthwise between the rails to make a smooth path. Right away the team swung off this on to the dirt so they could get a toe-hold.

There was no use yelling at them. The crowd was shouting and laughing and quarreling something awful; not to speak of making more bets every minute, until you couldn't hear yourself think. I just caught hold of one of the pipes and swung the load a bit to give it a loosening that the dogs could feel. A team always needs to have his sledge shaken loose this way on the trail.

The minute they felt the shake, the gallant little fellows went until their bellies nearly touched the ground. Their tails were straight out and their ears were laid back.

As the car began to move the crowd began to shriek louder than ever. It was a wonder the team didn't stop working to find out what was the matter with all the lunatics around them. Once the leader did take a quick slant at me; but when he saw my face he knew he'd better go ahead and pull.

First thing I knew, they broke into a trot. Then, for good measure, I hopped on atop the load and rode it right over the brow of the hill. Talk about your cheers! It was many a day before the contractor could get over the shock of seeing five little dogs out-pull his two swanking big dray horses.

Maybe you've heard of my famous dog "Baldy." He's generally spoken of as "Baldy of Nome." He and I went through some great battles together.

BALDY was built like a race horse: lean, long-limbed, and deep of chest. He was the most intelligent dog I ever had. Though he couldn't sign his name I think he understood every word I said when I talked to him.

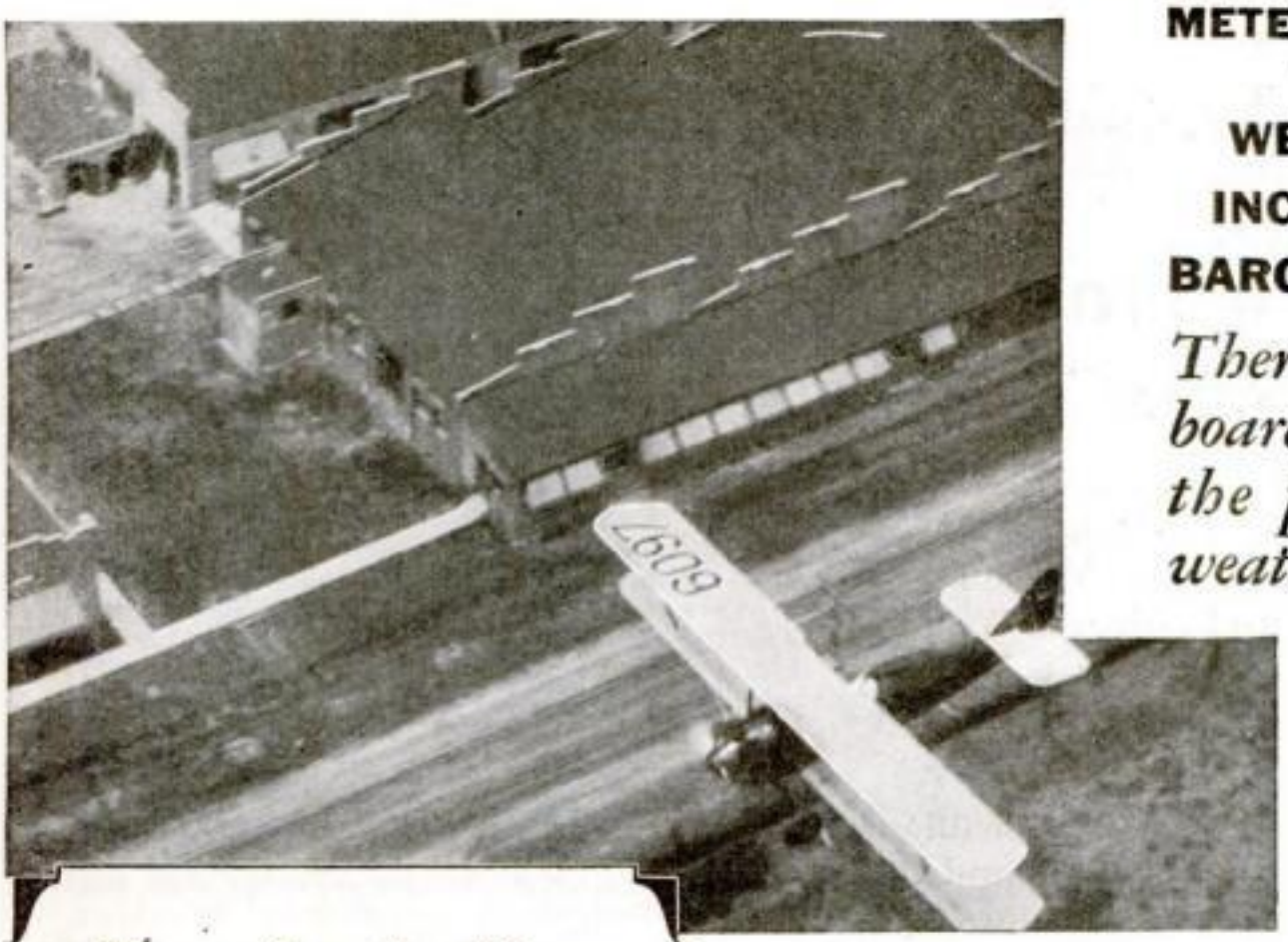
"Go and get my slippers," I'd tell him sometimes at home. I wouldn't nod or signal to the cupboard where the slippers were. But instantly Baldy would hop to his feet with a dog-smile on his handsome face and be back in a jiffy with my slippers dangling from his teeth.

I guess the worst time Baldy and I had was in the 1911 Sweepstakes. How we ever survived that race is more than I can say—except that Baldy, who was little more than a pup then, gets most of the credit.

In all, I drove in eight of the 410-mile races. I won three firsts, three seconds and two thirds. But there was none anywhere near as hard or as dangerous as that one in 1911.

A month before the race I took the dogs off seal and walrus, and put them on a diet of hamburgers made out of the best beef, mutton, and eggs. Three days' food just for the race alone cost me over (Continued on page 182)

We call your special attention to GOVERNMENT REGULATIONS FOR A. 1. A. RATING



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An instrument must be the result of infinite care in design and assembly and only the finest materials if it is to function as a truly scientific instrument applied to practical work.

All *Tycos* Instruments have earned that enviable reputation for accuracy and reliability. Taylor Instrument Companies' irrevocable policy has always been to make strictly accurate and reliable instruments—rather than to meet competition by producing inferior instruments at low prices.

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The booklet "Tycos Instruments for Aviation" is one of a series of informative literature covering every type of industry. These are mailed on request—or better still, our engineers will consult with you on the application of Tycos to your particular problem.

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THE ~ SIXTH ~ SENSE ~ OF ~ INDUSTRY

Tycos Temperature Instruments

INDICATING - RECORDING - CONTROLLING

Scotty Allan

(*Continued from page 180*)

$125. For the trail I had the hamburger put in two-pound balls, wrapped in cheese cloth and sealed in cans that I cached along the trail I must follow. This was all a secret from the other drivers.

The town was jammed with settlers, prospectors, Eskimos and other adventurers. It was carnival season.

We started in a howling blizzard. The drift was so thick that I couldn't see Baldy at the head of the team. When I passed the first three stations out I yelled my name and number, but the gale drowned my voice. As a result those at Nome received telephone messages that I must have been swept away on the sea ice, which meant that I had either drowned or been frozen to death.

When I crossed an inlet some miles up the coast the wind blew the dogs right off their feet, whirled them around and slammed them back up against the shore. But I was prepared for this. I put creepers on my boots and hauled them across the smooth ice on which they couldn't get a footing.

IT GOT worse and worse. The blizzard literally blew my breath down my throat. How Baldy was able to stick his nose into that blast and keep going was a miracle.

More dead than alive I made the turn and started back. About halfway to Nome the wind shifted and was in our faces again. Then came the jam that nearly put me out of the running, though I was far ahead of the next team.

As I was plowing along trying to keep my eyes clear of snow I felt my team suddenly swerve to one side. The next thing I knew, a gaping black hole opened in the white wall of the storm and the team dashed through.

I found myself inside the shack of a half-breed named "One-Eye." The whole team was in there with me, bewildered and half-blinded, getting all tangled up in their traces and beginning to fight.

"What in h—l do you think you're doing!" I yelled at One-Eye.

He rubbed his hands. "Ah, very bad, very bad, Meester Allan. You are lucky to be in out of the storm."

Then, in a flash, it came to me what it all meant. One of the crooked betting rings in Nome had bribed this fellow to head me off and hold me up.

"*Open that door!*"

But the halfbreed only stepped in front of it and put his back against it. As I knew he was probably armed I had to act quickly.

"*Get out of the way!*" I yelled and let drive with my whip not three inches from the end of his nose.

BALDY knew what was up, all right. He made a rush at One-Eye, snarling as he went.

The whip and Baldy's deep-throated threat broke One-Eye's will. He ducked as I threw open the door. The team shot through out into the smother of snow again and disappeared in the direction of Nome so quickly that I almost got left behind.

Meanwhile most of the telephone connections blew down. Bettors who were against me decided that I was out of the money and began to double their wagers on my nearest rival. But my friends stuck by me, though they felt pretty low. There certainly was a lot of excitement when I surprised everyone by coming in first. My time was seventy-six hours from leaving Nome until arrival back—total distance 410 miles.

Boisterous friends carried me to the Board of Trade Saloon where I was given a prize of a loving cup filled to the brim with gold coin. It contained $10,000 in all! In my frazzled condition I thought at first I was seeing things. But I wasn't.

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hum-free operation, tremendous "kick" on distant stations and razor-edge selectivity—with its costly sturdy construction, latest features, including phonograph pick-up connection, ease of tuning, beauty, and economy—a Miraco will make you the envy of many whose radios cost 2 to 3 times as much!

Many thousands of Miracos—bought after 30 day home comparisons—are cutting through locals and getting coast to coast with the tone and power of costly sets, their delighted users report. Miracos are laboratory-built with finest parts, and embody 9 years' actual experience in constructing fine sets. Approved by Radio's highest authorities.

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Everything reaches you splendidly packed and rigidly tested to insure your instant enthusiasm. Enjoy the outfit 30 days—then decide. Liberal 3-year guarantee on each set. Play safe, save lots of money, and insure satisfaction by dealing direct with Radio's old, reliable builders of fine sets—9th successful year.

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With its rich, clear Cathedral tone,

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On the Miraco Unitune, to start with, will say: I got to date 61 stations outside of Chicago, from the Pacific Ocean to the Atlantic Ocean, and from Anchorage, Alaska, to the Gulf of Mexico, and I tried the set with 3 different antennas. That is an outside aerial 152 feet, an inside aerial 20 feet, and light socket. I want to say that your set does outperform the other sets I have. I put it up against a World Record Super 9 and beat that one. Then I put it up against a (names expensive make), and beat that one. Next I put it up against a Neutrodyne and beat that one. HARRY KOPP, 6555 South Peoria Street, Chicago, Illinois.

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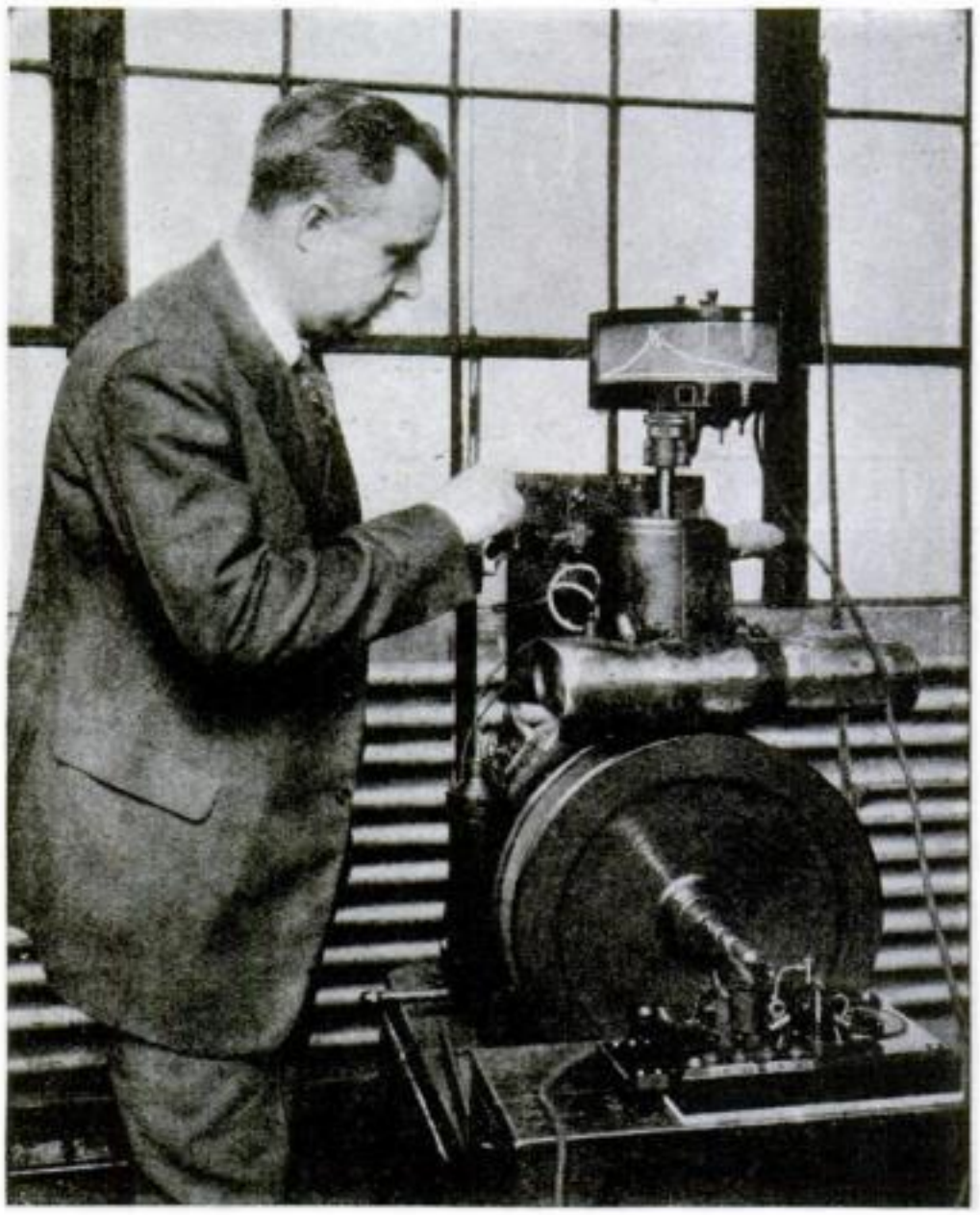
Above, popular inexpensive combination. Set on Table Speaker (sold separately).

Metal or wood compact style cabinets. Wood cabinets in walnut or new shaded silver-chrome finishes. Cathedral Electro-Dynamic or Magnetic-Power Speaker to match!

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8

On the trail of the "KNOCK" *(The indicator hound)*



This is Thomas Midgley, Jr., the inventor of Ethyl Gasoline, and the Midgley Optical Indicator, the machine which played such an important part in the development of Ethyl. The Midgley Optical Indicator, mounted on an engine, took a picture of what occurred inside the combustion chamber and enabled Mr. Midgley and his associates to establish the cause of the "knock."

WHEN you hunt a wild animal, you usually take along a dog that can follow the animal's trail. So when the scientists in General Motors' Research Laboratories started to trail the elusive and annoying "knock" in the gasoline engine, they had to develop a sort of scientific dog that could show them where the knock was and what sort of thing it was.

It is rather disrespectful to call the Midgley Indicator a "scientific dog." It is a most ingenious mechanism that records the pressures in the cylinder of a gasoline engine while it is running. By studying these pressures the scientists found out what was happening when the engine knocked. In fact, they found that it was the *fuel* that knocked, not the engine.

It was all part of the long trail of investigation that led to the discovery of tetraethyl lead as an anti-knock. To-day leading oil companies add Ethyl fluid (containing tetraethyl lead) to gasoline. As Ethyl Gasoline, this better fuel is now available all over the country.

But Ethyl Gasoline has done much more than eliminate the "knock" in gasoline engines. It has made possible the construction of high compression engines. With these it has introduced a new era of motoring comfort and efficiency.

The millions of cars of ordinary compression run better on Ethyl too—for carbon formation automatically raises their compression. Have *you* tried Ethyl?

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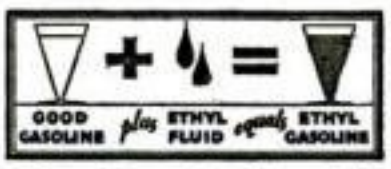

Knocks out that "knock"

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No experience is needed when you use "Rogers." No skillful brush work is required. Simply flow on the rich "Rogers" color with a full brush. "Rogers" quickly levels itself. Then it "Dries while you wait." Dries smooth—no laps nor brush marks. Dries to a tough, hard, porcelain-like finish that wears and *wears* and WEARS.

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"Rogers" colors are outstandingly beautiful—and modern. There are 26 standard colors. In addition there are black, white, clear and six new rich dark colors suited to outdoor as well as indoor uses.

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